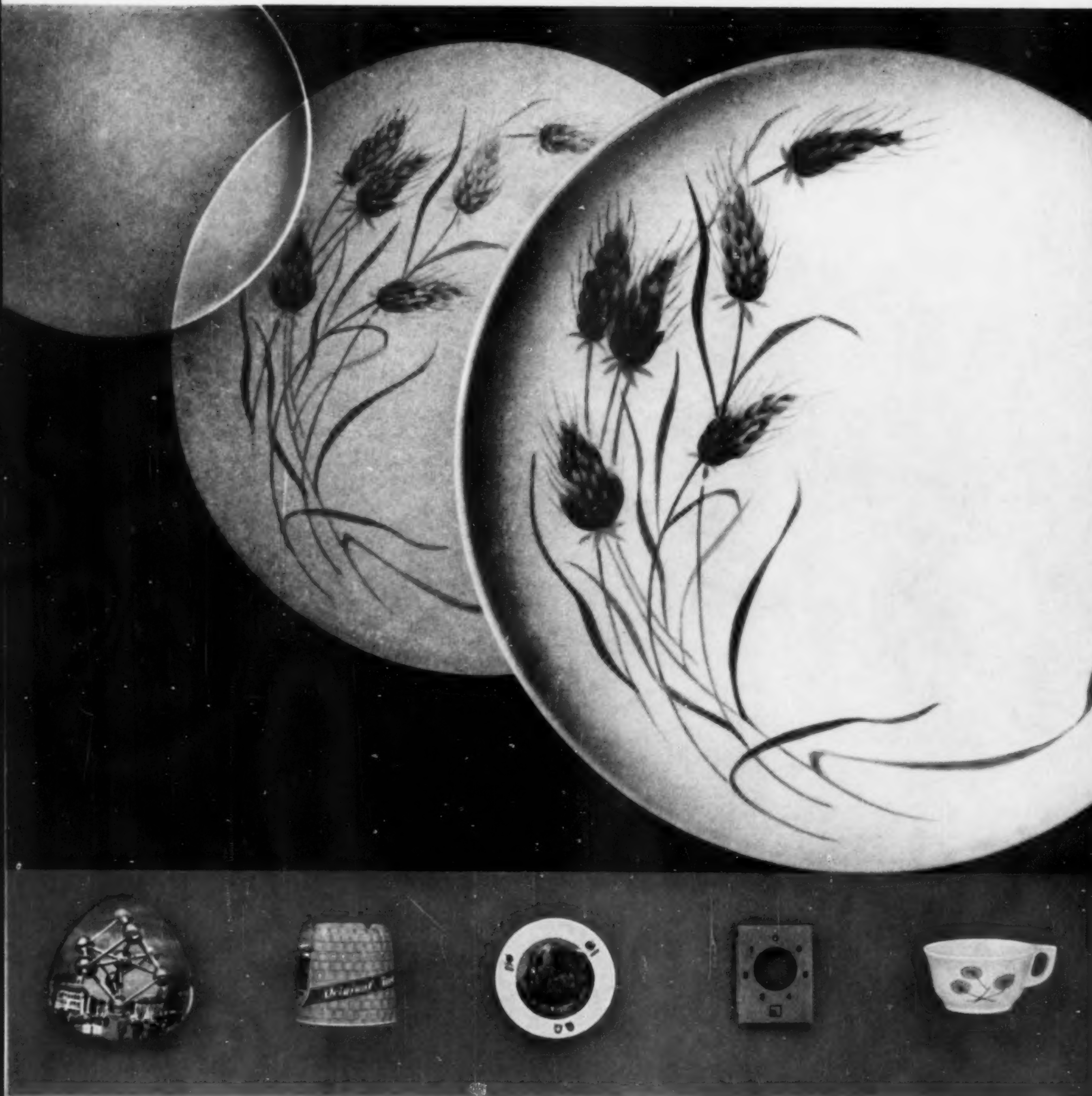
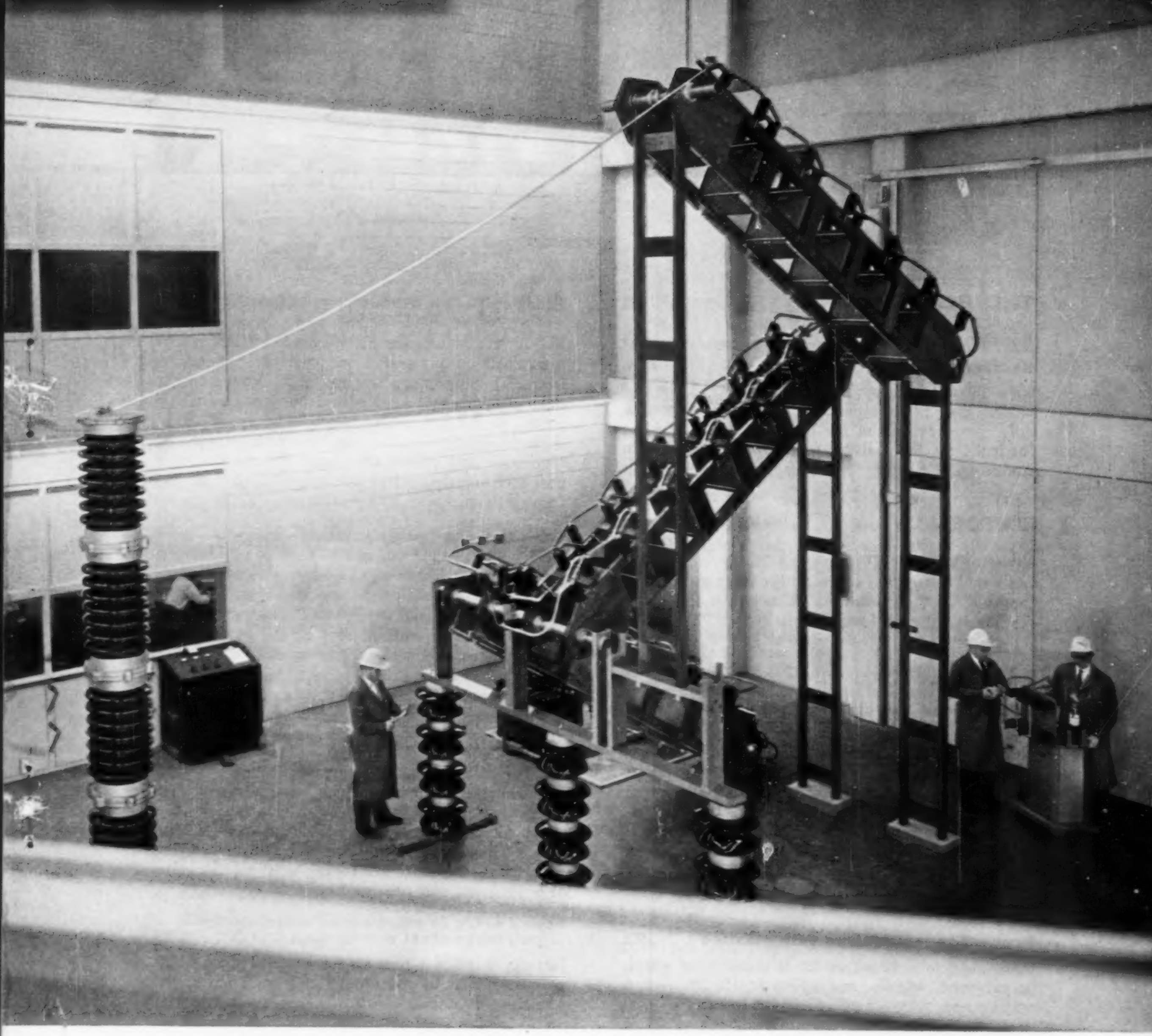
MODERN PLASTICS

JUNE 1960



PHOTOGRAPHED FOR MODERN PLASTICS BY RUDY MULLER



MODERN

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- **THE PLASTISCOPE**

New entrant in isocyanate field (p. 41); Dow develops two high-impact polystyrene resins (p. 214); price reduction for nylon (p. 41); Plastics Institute in formative stage (p. 230); Plastic smoke (p. 220).

- **EDITORIAL**

Let's make sure the price cutter does not gain a foothold in the melamine dinnerware field and destroy it through lowered quality.

- **GENERAL**

Is the molding of expandable polystyrene bead going to be the next major breakthrough in plastics? From a few pioneers in 1955, this segment of the industry has grown to over 100 custom molders today. Double that number, plus uncounted proprietary operations, are expected within the next five years. What are the markets, the materials, and the equipment necessary to get into the business? This first article in a series gives the answers.

Semi-automatic letter sorter that relies on vinyl, polystyrene, acrylic, and nylon for function and appearance brings new efficiency to mail operations. Each unit consumes hundreds of pounds of materials. Installed in several key post offices, the unit's success carries important implications for manufacturers of office equipment.

A major stumbling block in the sale of plastics drawers has been the fact that, despite offering many advantages, they essentially duplicated the appearance of standard wood construction: a rectangular box open at one end. A new approach, based on specially contoured storage units, thermoformed from polystyrene sheet, may help break this bottleneck.

Major breakthroughs in decorative foil extend market from melamine to urea and phenolics, from flat dinnerware to cups, soup bowls, and to deep-drawn and compound-curved industrial parts. Decorated dials, escutcheons, and other scale devices are among latest markets. Molded-in markings and colors eliminate the necessity of post molding decorative operations. The most advanced examples of this technique are illustrated.

Two-tone truck bodies are finished with greater efficiency through use of "magnetized" molded reinforced plastics "stencil." One major car maker saved a quarter million feet of 1½-in. masking tape and hundreds of thousands of feet of kraft paper by adopting this system. The technique is directly applicable to mass-production decoration of other compound-curved products.

Pioneer of the mass-produced car applies its engineering know-how to establish automated and integrated plant for production of high quality vinyl-coated upholstery fabrics at competitive prices. Here are the full details of the operation. Floor plan, keyed to photographs, shows location of equipment and process flow.

Development of a process for bonding decorative polyester film to continuous coils of strip metal promises to widen plastics' penetration into the metal fabricating industries. Price of the new material is between vinyl-metal laminates and plastisol-coated metals. TV cabinets and institutional furniture are among first commercial applications.

Design potential of material is exploited to the fullest in five outstanding European applications that are reported here.

Special four-page report summarizes the significant developments at the recent Florida meeting of the Society of the Plastics Industry Inc.

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PLASTICS*

JUNE 1960
Volume 37 Number 10

• ENGINEERING

• TECHNICAL

• DEPARTMENTS

Coming Up . . .

One of the difficulties faced by the prepreg industry has been the lack of uniform standards. Our July lead takes a close look at this problem, shows what's being done to overcome it. . . . Second in our polystyrene foam series reveals the fabulous market of bead board. . . . Ten significant predictions for the 60's. . . . Who's going to be in polycarbonates and what are the markets? . . .Engineering Section will feature article on how to extrude polypropylene film. . . . Technical Section lead will report on the steady-state flow properties of molten polymers and the effect of pressure on these properties. . . . Also in the works: Giant RP structures for industry. . . . The place of diallyl phthalate laminates in the high-pressure laminate field. . . . The Bissell floor appliance revolution. . . . Air conditioning with polyester bags. . . . When and how to use pressure forming. . . . A comprehensive plastics identification chart. . . . Plastics in lighting applications.

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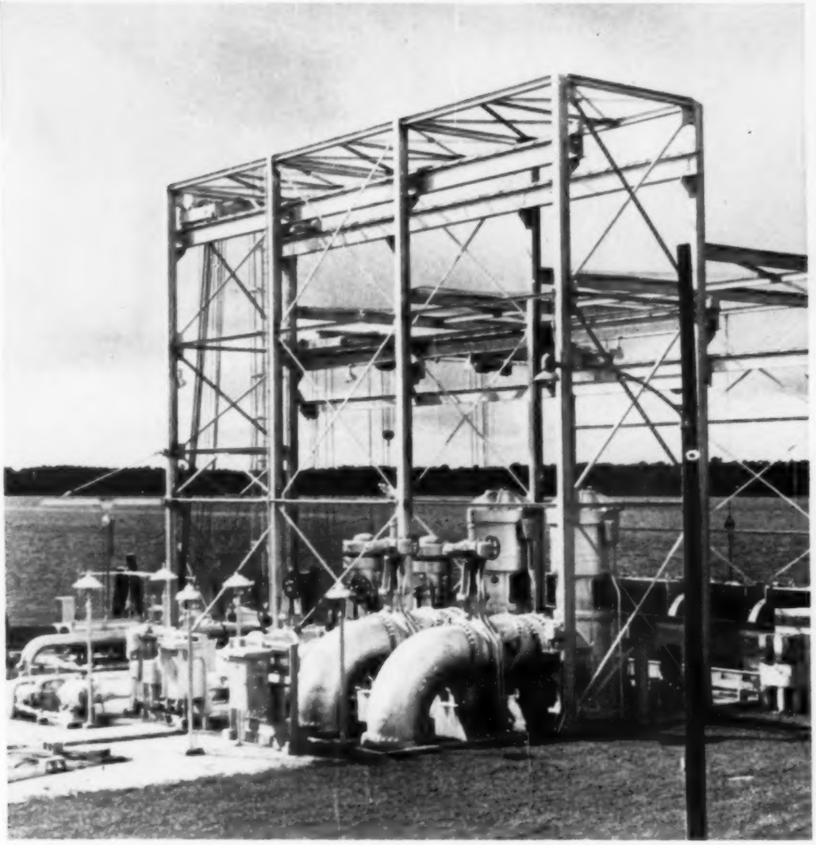
News about

B.F.Goodrich Chemical *raw materials*



Florida Power & Light Company uses anode racks made of Geon vinyl pipe. Fabricated by F P & L plant personnel at this job. B.F.Goodrich Chemical Company supplies the rigid Geon vinyl. These photos show intake structure at Palatka plant on St. John River, one of many places anode racks of Geon are used.

FP&L fights underwater corrosion with anode racks of rigid GEON

Underwater steel structures corrode when they are attacked by galvanic currents. Florida Power & Light engineers solve the problem two ways. They reduce effect of galvanic currents with an opposing voltage and they suspend anodes of graphite to bear the brunt of any continuing flow. These anodes rest in frames made of rigid Geon pipe.

Vertical side frames are 2″ Geon pipe and trays are open sections of 5″ pipe. The only effect on the racks of Geon is the marine growth shown in the photo at upper right. This growth is easily washed off, as photo at lower right shows.

Here's another example of the way Geon vinyl can solve corrosion problems for utilities. As pipe, as conduit, or as coatings, you'll find Geon vinyl is often the answer to your corrosion problems. For more information, write Dept. GJ-6, B. F. Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

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CELANESE MATERIALS REVIEW

- FORTIFLEX linear polyolefins
- FORTICEL cellulose propionate
- ACETATE molding compounds
- ACETATE sheeting
- POLYESTER resins

CELANESE TECHNICAL SERVICE

How to put more experts on your team without extra cost

Celanese has the technical experts who can help you get the most out of plastic materials at any stage from design to final product testing. Here's a rundown on the technical services Celanese can provide with respect to molding.

DESIGN CONSULTATION

In the final stages of a design, you can call on Technical Service to review the design from the standpoint of molding technology. At this point it is possible to forestall problems of moldability and strengthen critical points by simple means such as changing a radius—without affecting basic design.

ASSISTANCE WITH MOLD DESIGN

Celanese Technical Service is prepared to review mold designs and offer recommendations. This includes mold cooling, gate location, sizes of gates and runners, etc. It's surprising how much a slight variation from optimum in mold design can affect the quality of the molded piece. Form retention, surface quality, freedom from warping and sinks, demand a precise knowledge of the geometries involved as well as of the materials.

MATERIAL SELECTION

Literally dozens of basic formulations of the Celanese plastics exist, and new formulations are possible to meet the needs of molders. They vary in melt index, flow temperatures, molding properties, and end-use properties. Often, formulations are available for special needs, such as flame retardant or light stabilized properties. Here Celanese technical assistance is invaluable in coming up with formulation recommendations that will be most suitable for your product.

EQUIPMENT AND ITS ADAPTATION

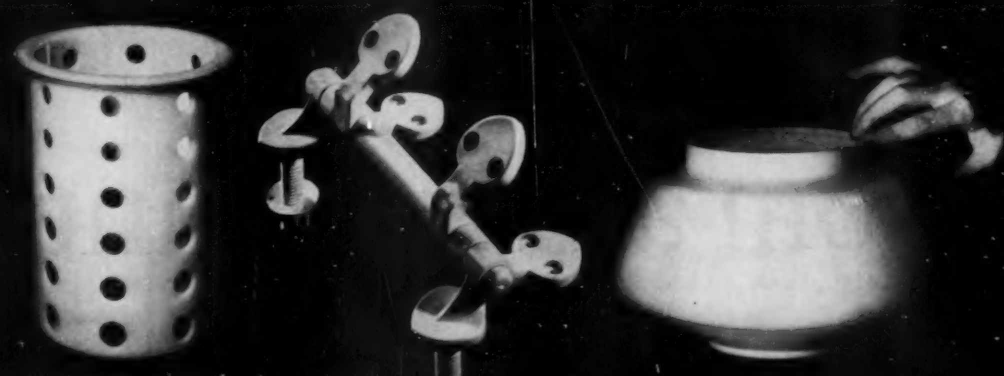
Celanese Technical Service will be glad to discuss your equipment requirements or needed modifications. For example, you may benefit from their knowledge of auxiliary molding equipment, or cooling processes, or the details of molding machinery.

PILOT MOLDING SUPERVISION

Celanese technical experts will help you supervise the first run of material. If material difficulties arise at the molding trials, they will make suggestions for changes and cooperate with you on additional trials. If you desire, they will send samples of the molded parts to Celanese Service Laboratories for evaluation.

This service is available to you now. It can help you avoid pitfalls and save you time and money. For further information, check the coupon.

RUGGED, ECONOMICAL MOLDINGS ARE MADE OF CELANESE FORTIFLEX



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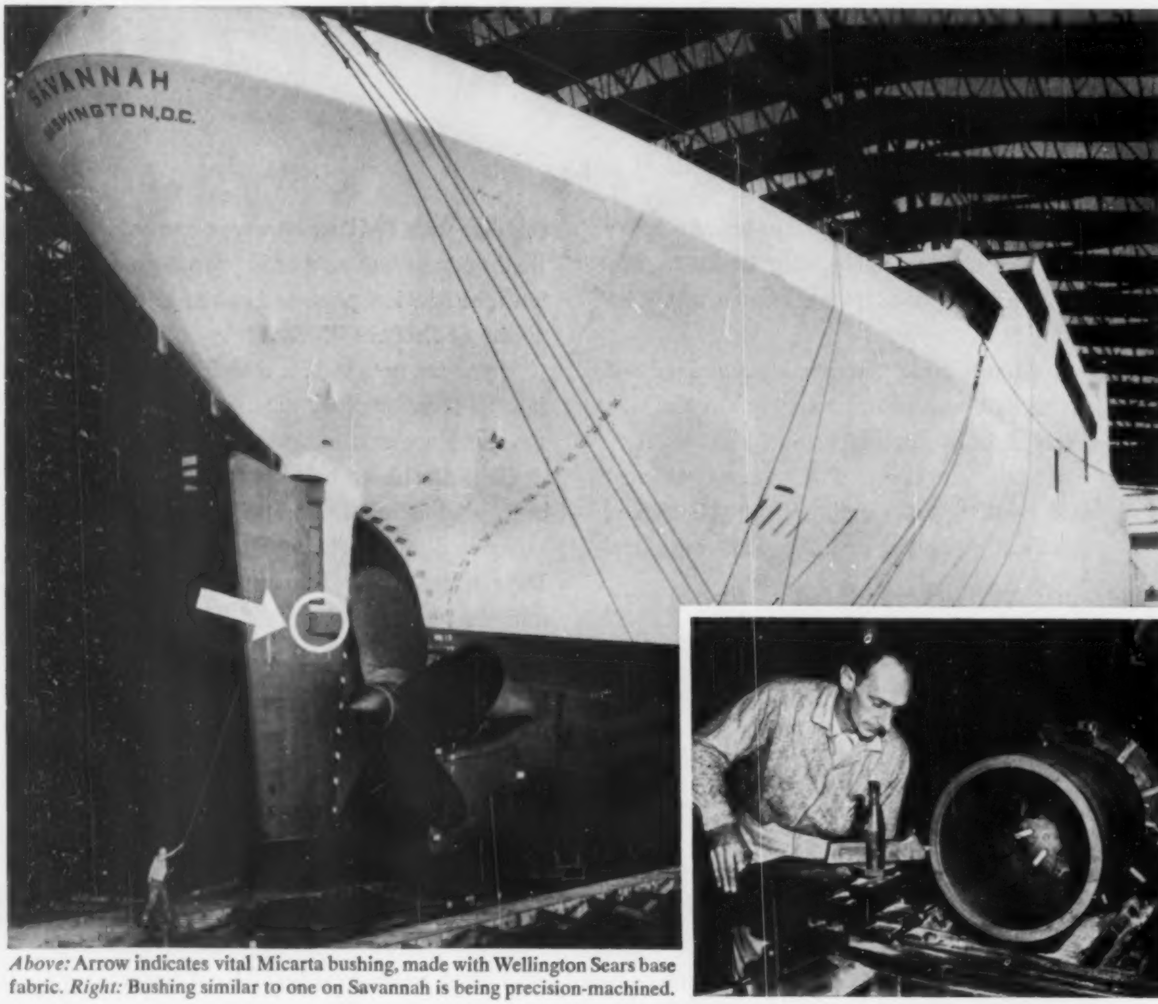

Above: Arrow indicates vital Micarta bushing, made with Wellington Sears base fabric. *Right:* Bushing similar to one on Savannah is being precision-machined.

With the N. S. Savannah ready to start setting new transoceanic speed records for merchant ships, a 60-lb. bushing enclosing its rudder pintle assumes great responsibility for keeping the nuclear-powered ship on course.

This type of bushing, while relatively insignificant on ordinary vessels, is of great importance on the Savannah because of the unusual stresses placed on the rudder by the ship's added speed.

The material selected for this vital job is Westinghouse Micarta, using Wellington Sears base fabric. This phenolic laminate was chosen, according to architect George G. Sharp, "for economy, utility, efficiency, and safety of the ship." The bushing was fabricated by Hershell Engineering & Supply Company of Philadelphia, a member of the Micarta Fabricators Association.

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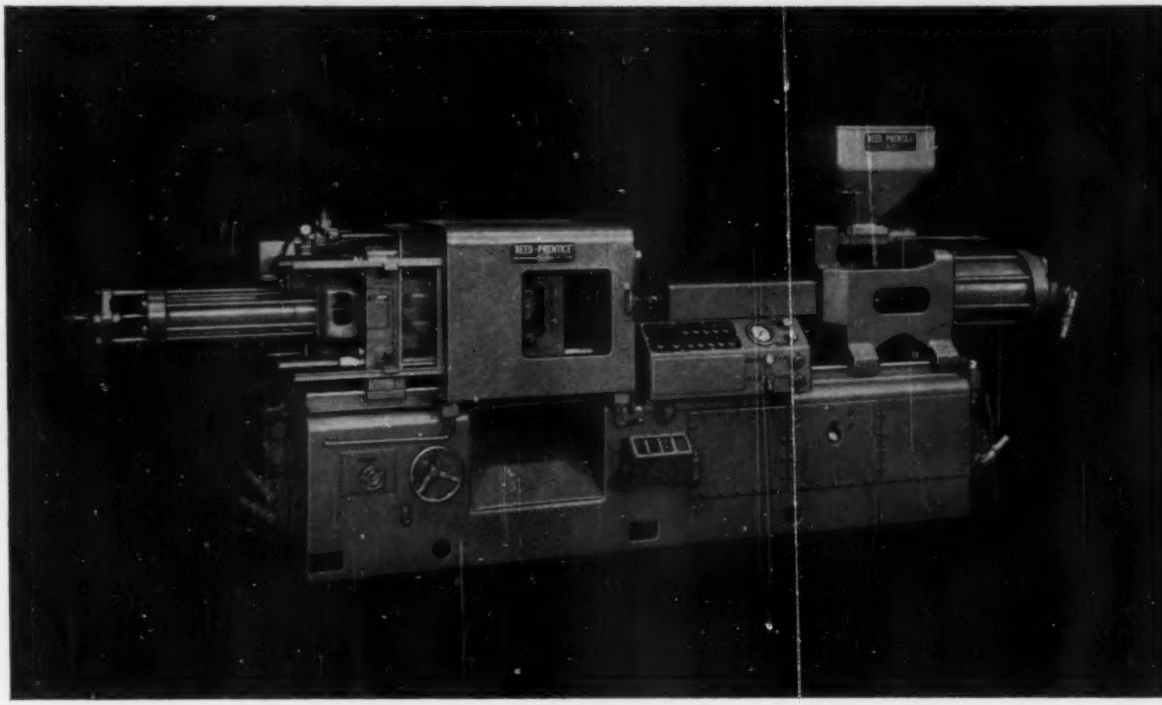

NEW REED 275TA-8/10 oz.

gives you longer stroke . . . larger platens

Here's another new Reed-Prentice injection molding machine designed to keep molders ahead of fast-rising production costs. The 275TA has been developed to handle larger molds at high speeds, provide a longer stroke. It is equipped with a completely redesigned safety circuit. These extra features add up to lower unit costs and greater profits to the molder. Look at these big features on the new REED 275TA.

▶ **LARGER PLATENS.** Die plate measures 27 x 27¼, provides a 15½ x 15½ inch space between tie bars.

▶ **NEW, ADJUSTABLE LONG-STROKE.** Redesigned link end gives a longer, more flexible adjustable mold clamping stroke. You get more than a 50% increase in mold depth.

▶ **NEW SAFETY CIRCUIT.** Front safety door is equipped with double limit switches and a hydraulic lock. The limit switches are interlocked with a hydraulic arrangement that is self-monitoring. If any part of the safety circuit fails, the machine will open and stop, providing the ultimate in personal safety.

▶ **FASTER, EASIER SETUP.** Hydraulically-operated die space adjustment and plunger housing speed setups, eliminate nozzle breakage.

All REED injection molding machines are designed to boost output and cut production costs . . . to keep profits at a high level. For complete information on the new 275TA and the full line of REED injection molding machines, call your nearest REED Sales Engineer.

NEW 275TA SPECIFICATIONS

Mold Clamping pressure, tons	275
Mold clamping stroke (adjustable)	6¼ to 11½"
Platen Size (Horizontal & Vertical)	27 x 27¼"
Diameter of Tie Bars	3½"
Space between tie bars	15½ x 15½"
Plasticizing Capacity (lbs. per hour)	120
Cycles per hour (maximum)	470

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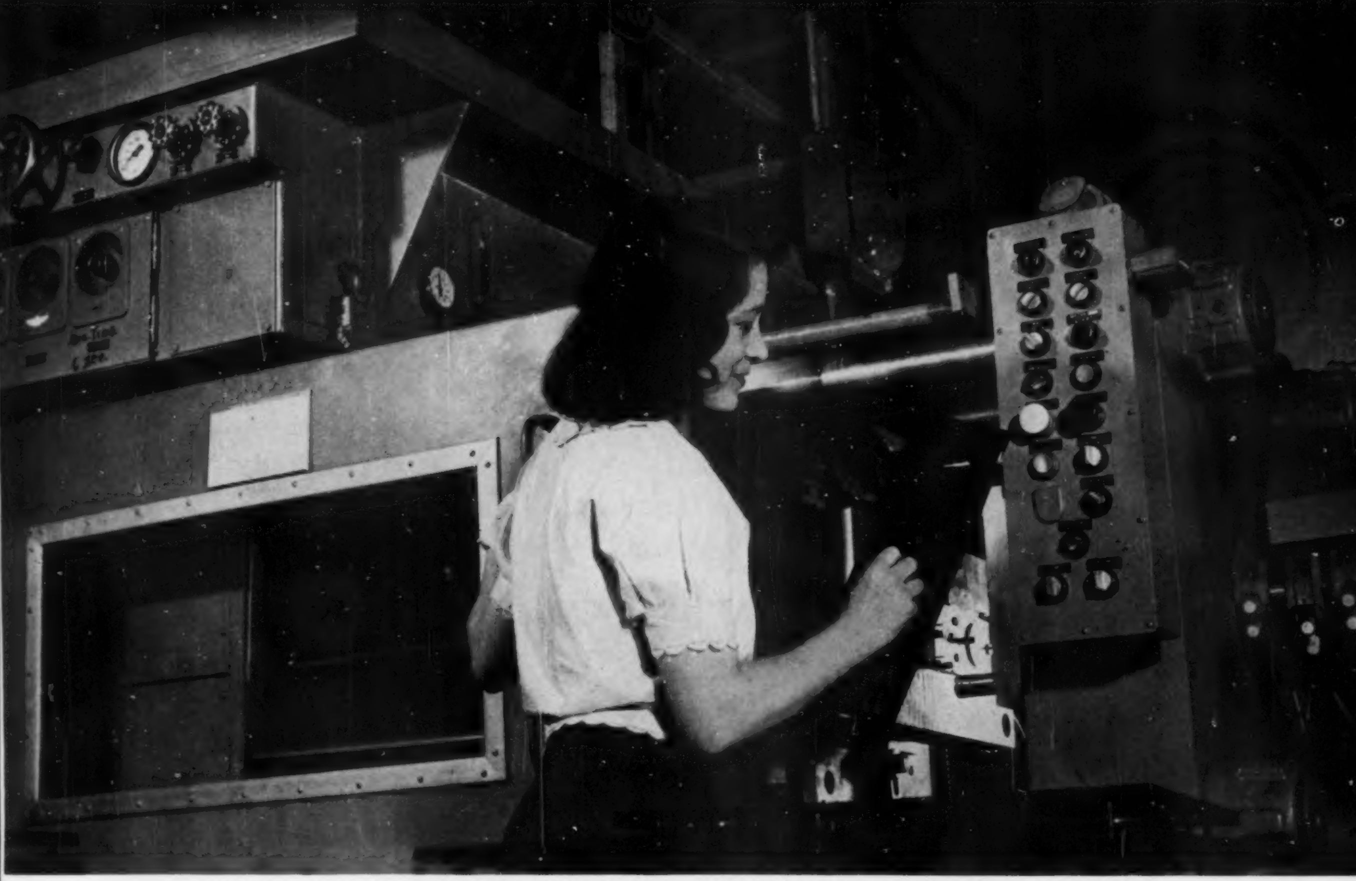

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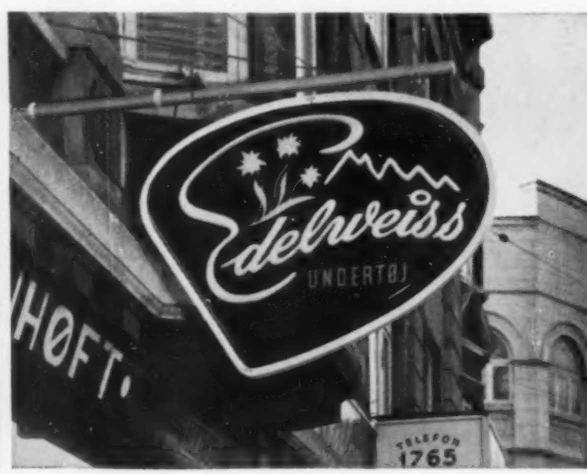

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Canadian enquiries to: Canadian Industries Ltd., Plastics Division, Box 10, Montreal P.Q.

P739/0/A

Breakthrough!

New kind of stretchable decorative "foil" successfully used in molding deep-draw melamine pitchers, cups and industrial items—New "foils" also successful in reproducing full-color, black and white photographs. Developments open an exciting new era for melamine, urea products, and even combinations with certain phenolics.

Ornapress A. G. of Switzerland, pioneer in the development of melamine decorative "foils" for dinnerware, and perfecter of the deep-draw process, has now successfully employed a new type of stretchable "foil" in the molding of deep-draw pitchers, beer mugs, ash trays, cups, dials and a host of industrial products. Additionally, Ornapress and Fairhaven Properties Corporation—in a joint collaboration based on pooling of patents and know-how—have reproduced in "foils", full-color photographs for molding into various items. They have also discovered an economical means of reproducing black and white photographs for molding into plaques, hot plates, souvenir, and many other products. The implications of these developments are literally breath-taking. They promise veritable revolutions in the manufacture and sale of "foil" decorated tableware, souvenirs, signs and industrial items.

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* = molding
** = foils production

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Owner of Ornamin decorating processes and patents.
Foils production. Molding. Molds manufacture.

THE PLASTISCOPE*

News and interpretations of the news

By R. L. Van Boskirk

Section 1

June 1960

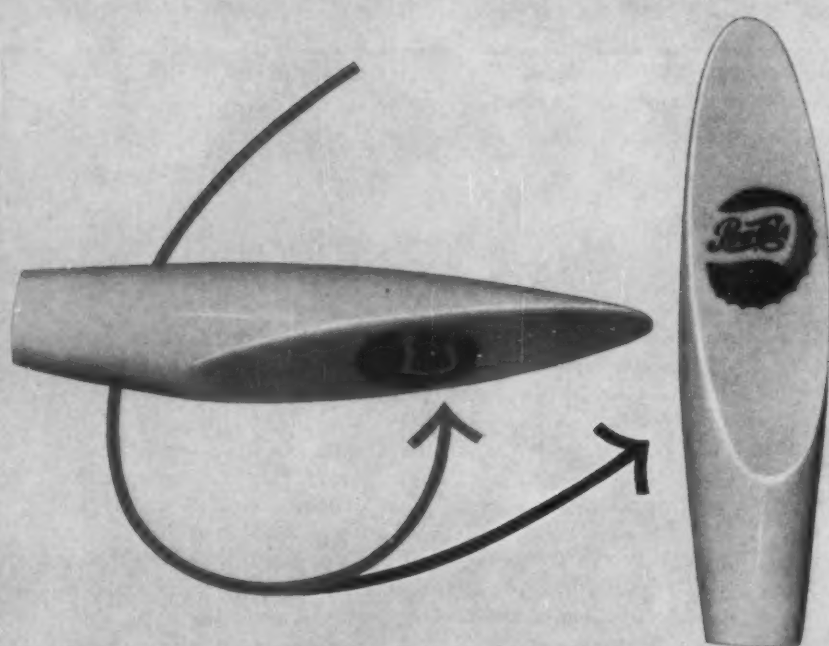
New entrant in isocyanate field. In spite of the consistent and rapid growth of urethane foams since they were first introduced commercially about five years ago, no new suppliers of isocyanates—the basic ingredient for urethane foams, coatings, and elastomers—had been tempted to compete with the three original producers of toluene diisocyanate (TDI)—Mobay, Du Pont, and National Aniline Div. of Allied Chemical. Part of the reason lies in the complicated process, which consists of nitration of toluene to dinitrotoluene, catalytic hydrogenation to diaminotoluene, and reaction with phosgene to yield TDI. Now Nopco Chemical Co., Newark, N. J., a producer of flexible urethane foam and supplier of prepolymers, has announced plans to construct a TDI plant with a capacity of 10 million lb. at a cost of approximately $7 million, scheduled to be in production by January 1962. The combined capacities of the three current producers of TDI are around 50 to 60 million lb., with sales expected to reach close to 40 million lb. by the end of the year. Although the additional 10 million lb. capacity planned by Nopco will be needed by 1962, Mobay, Du Pont, and Allied have kept TDI production well ahead of sales, and are expected to announce further expansion plans this year.

Industry capacity for isocyanate. Nopco's announced capacity is thought to be a minimum for economic production, even at the present price level of 70¢/lb., and a 50¢ to 55¢ level may not be far off. Nopco expects that captive consumption will be such that the plant can begin operation at a high level of production. Since TDI content in urethane foam formulations averages about 30%, this would mean that the company plans to sell between 20 and 30 million lb. of foam—compared with an estimated 5 million lb. it now produces.

Almost simultaneously with Nopco's announcement, Allied revealed the availability of a new grade of TDI, designed especially for rigid foams and selling at 60¢/lb. Called Nacconate 4040, the new grade is expected to give big impetus to the use of urethane foams in the refrigeration industry and in panel making. The availability of this lower cost isocyanate now completes the replacement of all the ingredients formally used to make rigid foams, by much less expensive materials. Now rigid foams will be made with polyethers instead of polyesters; by the one-shot method instead of the prepolymer techniques; and with the use of fluorinated hydrocarbons (Freon, Genetron, Ucon, and Isotron), which provides about twice the insulating efficiency of the earlier types of urethane foams. So far, rigid foams, mainly for refrigeration account for 10 to 15% of the estimated 110 million lb. urethane foam market for 1960. Allied expects Nacconate 4040 will sharply increase that percentage.

Price reduction for nylon. Allied Chemical reduced the price on nylon molding material from $1.18 to $1.11 on May 19 "to make it fully competitive with formaldehyde polymers," according to the press release. Allied's (To page 43)

*Reg. U. S. Pat Off.



Another way to make folks say, "Make mine a Pepsi"

Photographs can't do justice to the beauty, utility and durability of this Pepsi-Cola dispenser handle. Molded of gleaming white melamine with the famous red, white and blue Pepsi bottle cap in permanent molded-in color, it provides that all-important instant identification to the thirsty millions who prefer this popular beverage. Handsome, yes, plus all the strength and rigidity needed to meet the rigorous demands of fountain service.

The Pepsi handle is not an ordinary molding job. In fact, it involves some rather unusual techniques which come only with years of experience. And that is, of course, a mighty good reason to specify CMPC on your next job.

This is another CMPC "White Gloves" molding. For maximum protection against material contamination, this product was molded under highly controlled production conditions involving special dust control measures and a protective materials handling system. This is another example of CMPC's specialized techniques and facilities for producing the best in molded plastics.

CMPC

CHICAGO MOLDED PRODUCTS CORPORATION
1020 A North Kolmar Avenue
Chicago 51, Illinois

THE PLASTISCOPE

(*Continued from page 41*)

polymer, nylon 6, is made from caprolactam, as is that produced by Foster Grant and Spencer, who quickly followed the Allied action with a similar reduction. Du Pont, who also makes a caprolactam polymer, Zytel 211, but whose chief item is Zytel 101, the original general-purpose nylon 6/6 American-type (caprolactam types are more universal in Europe) followed the pattern and also reduced the price of most of its nylons, except for Zytel 69, 61, and 63, which are specialty types for such things as wire coating and sell for from $1.68 to $2.18 a pound.

The polymer mentioned above is, of course, Du Pont's acetal resin Delrin, which was selling for 88¢, but will now very likely be reduced by a nickel or so to keep it slightly under nylon. The difference is accounted for by specific gravity. Delrin is being promoted primarily as competition for metals, but there is no doubt that it also fits into a variety of nylon applications.

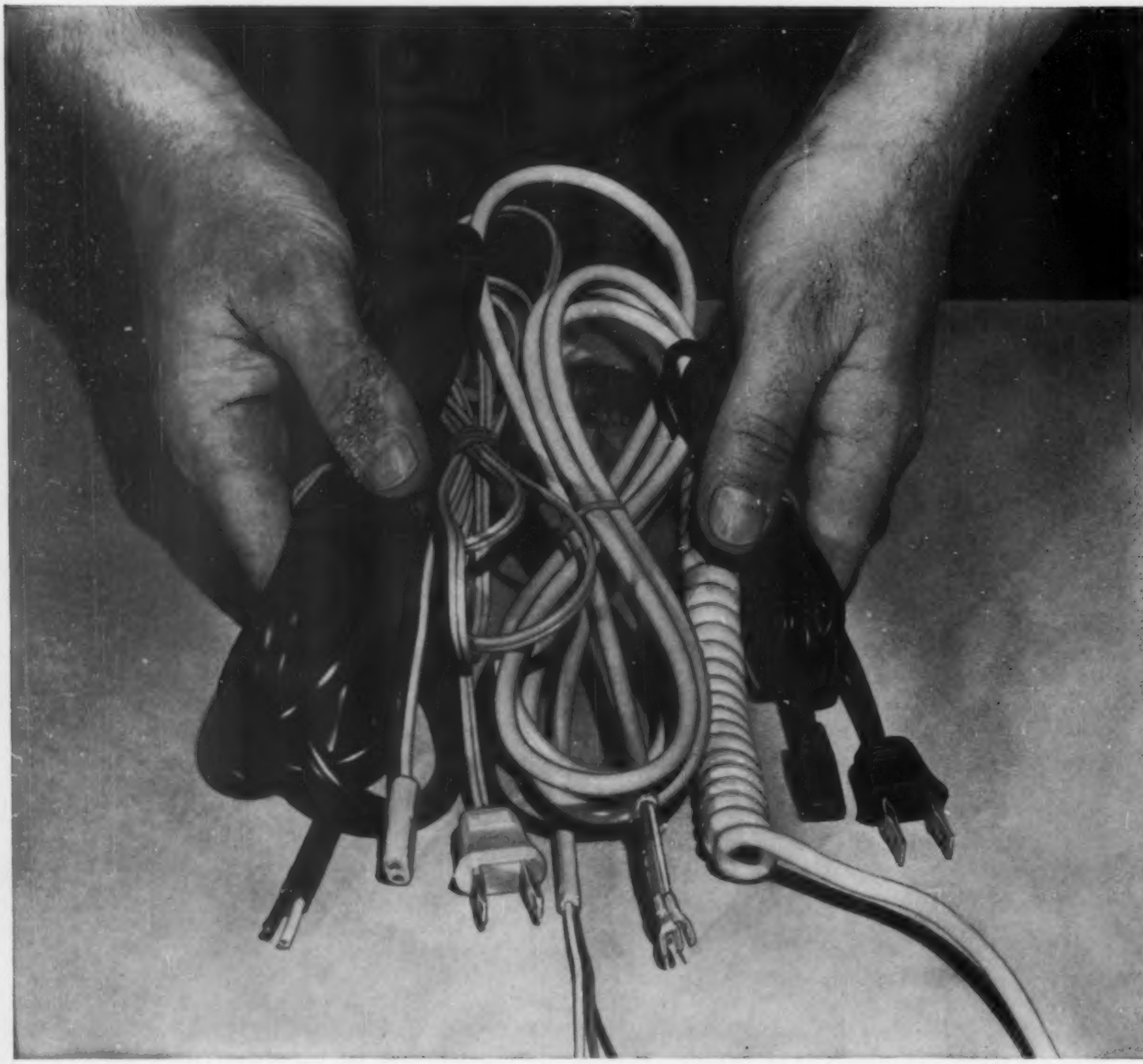
Giant chemical complex. A $50 million complex to convert hydrocarbons from gas or liquid fuel into acetylene and vinyl chloride monomer has been announced as a joint enterprise by The Borden Co. and United States Rubber Co. The site will be chosen at some location between Southeastern Louisiana and Corpus Christi, Texas, and is planned to begin operation in 1962, according to the two companies.

The enterprise will be called Monochem Inc. Both companies will erect adjacent individually owned plants, which will use the vinyl chloride, acetylene, or acetylene-derived products. The Monochem plant will be designed to produce more than 80 million lb. of acetylene and 150 million lb. of vinyl chloride monomer, which is a lot more than the consumption of these two vinyl chloride polymer producers today.

Red—bright or pale. A comparatively new red pigment (it's only two years old) is attracting a lot of attention in the plastics industry. Automotive firms took most of what was available last year, which means it had to have "oomph." Strangely enough, these pigments are at their very best in pastels, where fading has always been a particularly bad problem. The secret of pastel excellence is claimed to be that "even a little pigment goes a long way toward producing durable colors."

The new pigments are called Monastral by Du Pont. Uses in plastics include wall fabrics, floor coverings, table covers that will withstand washings, plastics signs, and garden hose. Pink and flame color, from Monastral, for plastics boats are said to be as lightfast as tints, resistant to alkali, heat, and salt water. The plastics industry's #1 appeal is probably color—and red is the leading hue. If there is one that never fades, it will be appreciated profitably as well as aesthetically.

National Sanitation Foundation approval. Penton, the resin developed from pentaerythritol by Hercules Powder Co. and noted particularly for low-shrinkage, high heat and chemical resistance, has been granted an NSF Seal of Approval for meeting the Foundation's requirements for use in products requiring nontoxicity. This approval is expected to lead to applica- **(To page 45)**



Need a quality resin accepted and approved for electrical applications?

VYGEN 120 PVC resin is UL-approved as interchangeable with other quality PVC resins for wire insulating applications. VYGEN 120 is specially formulated for fast economical dry-blend extruding, with monomeric or polymeric plasticizers. It assures a lack of gelled particles . . . provides excellent heat and light stability plus exceptionally long life. See how VYGEN can help your products . . . speed your production . . . send for complete technical literature today!

VYGEN®

VYGEN 85 Recommended for calendering, extrusion and molding operations where processing at low temperatures is desired.

VYGEN 105 — For light embossed sheeting and for molded items and extrusions requiring high gloss finish.

VYGEN 110 — General purpose resin for calendered film, sheeting and coated fabrics . . . molding and extruding. Excellent heat and light stability.

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THE GENERAL TIRE & RUBBER COMPANY
Chemical Division · Akron, Ohio

Chemicals for the rubber, paint, paper, textile, plastics and other industries: **GENTRO SBR** *rubber* **GENTRO-JET** *black masterbatch* • **GEN-FLO** *styrene-butadiene latices* • **GEN-TAC** *vinyl pyridine latex* **GENTHANE** *polyurethane elastomer* • **ACRI-FLO** *styrene-acrylic latices* • **VYGEN PVC** *resins* • **KURE-BLEND** TMTD *masterbatch* • **KO-BLEND** *insoluble sulfur masterbatch*

THE PLASTISCOPE

(*Continued from page 43*)

tions in water meters and sanitary equipment parts. The price has just been reduced to $2.50 a lb.—was formerly $3.50—and material is now also available for dispersion as well as moldings.

Pro-fax, the Hercules polypropylene, which was the first PP to receive Food & Drug Administration approval, is also now approved by NSF and is used for hot water dip-tubes and insert fittings for plastic pipe. Hi-fax, the company's high-density polyethylene, was also approved by NSF after five years of testing for potable water pipe.

Price juggling in vinyl chloride. Declines in vinyl chloride prices have been going on for several months, after most people thought that the 23½¢ price set in 1959 would prove stable for a long period of time. As we go to press, the price is 22¢ for general purpose resin. The perceptible reason is stiff competition in an industry that has more capacity than it has sales. Foreign imports of resin were less than 15 million lb. in 1959—9.6 million from Italy, 2.5 from Japan, and 1.5 from Canada. There is no sense in blaming the price decline on an import of 15 million when something like 850 million lb. of domestic resin were consumed. The matter of imported finished vinyl products could be much more serious if it continues to grow.

The biggest outlet for general purpose vinyl is calendering grade, with a market of around 200 million lb. a year. Some 40 to 45 million of this is calender-coated material. Paste or plastisol coated (spread coating) fabric must sometimes compete with this. So down comes the price of plastisol resin from 26½ to 25½ cents.

Unplasticized vinyl prices. The price of unplasticized vinyl resin compound was also reduced a month or so ago to 37½¢ from a previous 40½¢/lb. The reason was probably price competition from other thermoplastics. Between 18 and 20 million lb. of unplasticized vinyl resin were used for extrusion in 1959. Somewhere around 14 million were for pipe and tubing—the balance was in extruded shapes like window frames, flashing, etc. It is expected that the new Goodrich Hi-Temp Geon resin, polyvinyl dichloride, which will convey water at over 200° F. under normal pressure, will enlarge this field. A sales price has not yet been established for the new material when it becomes available in large quantities.

How much vinyl in 1960? Volume of all vinyl resin consumed in the first quarter of 1960 is still 10% over 1959—an estimated 215 million lb. or more, against 192 to 195. But that 215-million-lb. figure is under the 225- or 230-million lb. figure in the last quarter of 1959. However, that quarter included a record breaking 82-million-lb. month in October. The first months of 1960 are each about the same as the last two months of 1959, or in the neighborhood of 70 million lb. a month. But March was back up to 77 million pounds.

Industry estimates for 1960 are for a volume consumption of around 950 million lb., in contrast with 860 in 1959. This is not equal to the 200-million-lb. increase in 1959 over 1958, but it's a long step toward that 1 billion lb. figure volume-resin producers dream about. (To page 47)


THE
HANDBOOK
TITANOX

THE PLASTISCOPE

(*Continued from page 45*)

Polyethylene in 1960. Polyethylene consumption in the first quarter of 1960 was approximately 280 million pounds. This was probably 10 million lb. or so under the last quarter of 1959. The Tariff Commission figures for 1959 are somewhat confusing, since one company reported an error of 20 or 30 million lb. in sales volume, which was added on at the close of the year but did not show up in any of the monthly reports. However, the 280-million-lb. figure for the first quarter of 1960 is from 25 to 30 million lb. more than the sales volume reported in the first quarter of 1959.

But the first two months of 1959 were the lowest of the year at around 80 million lb. each. From then on the industry consumed resin at from around 90 to over 100 million lb. a month. Therefore, polyethylene must be consumed at an average of over 100 million a month in 1960 if it is going to show anywhere near the same increase in 1960 that it did in 1959; namely, close to 250 million. Thus if the industry is to sell 1,350,000,000 lb. in 1960, the monthly rate will have to average over 112 million pounds. The rates so far in 1960 have been: Jan., 84; Feb., 95; March, 101.

Polyvinylidene chloride latex coating resin. National Starch & Chemical has announced a polyvinylidene chloride latex system that results in a coating said to be competitive with polyethylene for materials such as paper, paperboard, corrugated liner board, other plastic film, etc. The resin is a water dispersion and is supplied at 50% solids. It is called Resyn 3600.

It is said to differ from other vinylidene chloride emulsions used for film and paper coating in that it is internally plasticized and, therefore, eliminates the need for plasticization by the processor. It is also claimed to be softer and more flexible than the coating sometimes used on cellophane, but this material is presently being pushed for paper and paperboard applications, rather than for film.

Markets include: 1) food packaging—milk containers, drinking cups, bread wraps, frozen food cartons, butter wraps—which could consume several million lb. annually; 2) industrial packaging—on kraft paper or corrugated liner board, for masking paper, hospital bags, cigarette packs, etc. Particularly intriguing is the possibility of packaging lube oils in such coated paper, which would be considerably cheaper than conventional metal cans. Non-packaging applications include textile coatings, vapor barrier for gypsum wall, base for adhesives. The coating is printable.

Cost is claimed to be less than polyethylene coating. Since Resyn 3600 is claimed to have three times the resistance to moisture vapor transmission than polyethylene, only one-third as much is required for a given area. It sells at 45¢ per dry lb. (22½ for emulsion) and 8 lb. of dry resin on a ream of 3000 sq. ft. of paper would give equivalent properties of 1 mil of polyethylene. A ream of paper would require 15 lb. of polyethylene for a 1 mil coating at 32½¢/lb. The price variation is therefore $3.80 for Resyn 3600, compared with $4.87 for PE, according to National Starch technicians.

Resyn 3600 will be produced at a new facility at National's Meredosia, Ill. plant. Capacity, when the new unit is in production, is said to be 14 million lb./year.

For additional and more detailed news see Section 2, starting on p. 214

NEW MACHINERY-EQUIPMENT

Specifications, claims made, and prices appearing in these pages are those of the manufacturers or sellers of the machinery and equipment described, or their agents.*

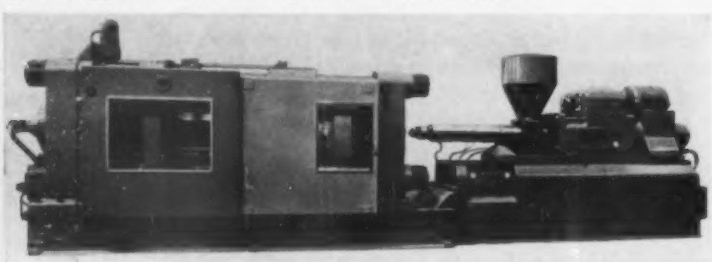
Foam machine

Designed for the production of urethane, polyether and polyester foam, the Armorbelt continuous foaming machine consists of a wide metal belt conveyor in a truss support. It is pivoted at the pouring end and is equipped with a handwheel-operated raising mechanism to adjust the conveyor the correct downward slope for proper foaming. The pouring end is equipped with side fences to support the pouring paper. The spacing between fences is adjusted by a single handwheel. Provision is made in both conveyor and side fences for heating the foam blanket. A remote-controlled variable-speed drive allows the operator to change speed during operation. An automatic takeup compensates for temperature changes. The metal conveyor belt is zinc coated for easy cleaning. It runs on a steel track and it laterally guided by ball bearing rollers to prevent layer separation of the foam. The conveyor body is fully enclosed. The unit is 80 ft. long and has a working width of 80 in. with a minimum fence spacing of 24 inches. The fences are 30 ft. long, with an additional removable 10-ft. section in the foaming head area. *M-H Standard Corp., 517 Communipaw Ave., Jersey City 4, N. J.*

Injection machines

Reciprocating screw injection machines can be supplied with four different screw sizes and five different cylinder sizes to suit individual processor needs. Thanks to the different cylinder and screw designs, shot capacities covering the range of 26 to 278 cu. in. are available. These machines are characterized by the use of a screw which also acts as an injection ram and moves axially within a single cylinder. Experience has indicated that this type of machine provides superior plastication of polymer melts compared to the conventional ram type machine without preplastication equipment. The significant specifications of this line, which includes models V-40-550, V-74-550, and V-90-1000 are shown in the table, below. Machines have been developed in cooperation with Ankerwerke, who also produce reciprocating screw machines. *Krauss-Maffei, A. G., München-Allach, Germany.*

KRAUSS-MAFFEI V-90-1000 reciprocating screw injection machine has typical piggyback drive mounting to turn injection screw.



Specifications: Krauss-Maffei injection machines

	V-40-550	*V-74-550*	*V-90-1000*
Injection volume, cu. in.[a]	26-73	58-165	95-278
Injection pressure, p.s.i.[b]	2700-18,500	2850-18,500	2850-18,500
Max. inj. rate, sec.[c]	3	4	5
Max. cycle, shots/hr.	130	120	100
Screw speed, r.p.m.	22-108	16-64	16-64
Plasticating cap., lb./hr.[d]	220	330	440
Clamp force, tons	640	640	1100
Daylight, in.	27½	27½	35½
Platen size, in.[e]	52	52	63
Daylight between tie bars,[e] in.	33½	33½	41
Net weight, tons	33	35	55

[a]Range depends on the size of cylinder specified. [b]Variable within ranges shown. [c]To deliver full cylinder of material. [d]In general purpose polystyrene. [e]Platens are square.

Extrudate cutter

Model M-420 Wink cutters are especially suited to the precise cutting to lengths of extruded plastic materials and may easily be incorporated in a completely automated extrusion line. Special scissors-like knives are used. Cutting action may be continuous or intermittent, in adjustable lengths up to 60 ft. (or more on special request). Materials may be sliced to as thin as $\frac{1}{16}$ in. in small-diameter stock. Extrudates up to 3-in. diameter can be handled. The machine will make an average of 200 to 1500 cuts/min., on a continuous basis, 3000 or more on some jobs; intermittent speeds range up to 225 cuts/min. The machine cuts to exact dimensions with little or no scrap or distortion of the piece. The cutters are available on lease, lease-purchase, or time payment plans. *Motch & Merryweather Machinery Co., Wink Div., 1250 E. 222nd St., Cleveland 17, Ohio.*

Cycle timer

In molding some plastics, it is necessary to release pressure for escape of volatiles, and then reapply pressure. This step is called bumping and may be required several times during the cycle. The E574S Robotron Time Cycle Controller regulates the spacing and number of bumps of a hydraulic press, the amount of press opening during each bump, the length of time delay before high pressure is admitted to the ram, and the total cycle time. High-capacity solenoid valves (supplied by Airmatic Valve Inc., 7313 Associate Ave., Cleveland 9, Ohio) that control air supplied to the press are mounted to the Robotron case at their electrical **(To page 50)**

* Prices are deemed to be F.O.B. sellers' plants (unless otherwise stated), are for "standard" models, and are subject to change without notice. The publishers and editors of MODERN PLASTICS do not warrant and do not assume any responsibility whatsoever for the correctness of the same, or otherwise.

(*From page 48*)

connections. The wiring is protected and air connections are outside the case. With the Robotron Timer, a press operating cycle can be set up in 15 minutes. All that is needed is to set four dials and a switch for each bump required in the cycle. The controller is set for the exact number of bumps needed in the cycle, each bump is set for the desired time in the cycle, the amount of press opening at each bump is controlled precisely, and the time for allowing high pressure to the press is also set on a dial. With this control, a minimum number of bumps can be used, thereby reducing strain and wear throughout the press. *Taylor-Emmett Controls Inc., 445 E. Turkeyfoot Lake Rd., Akron 19, Ohio.*

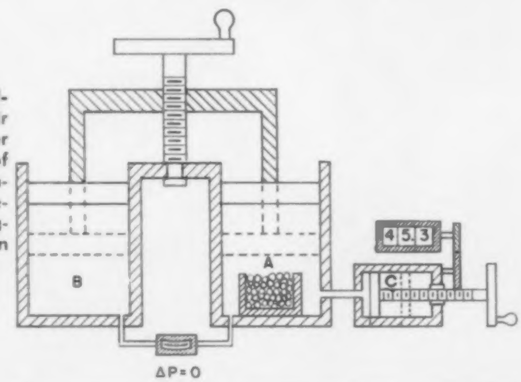
Volume meter

This ingeniously simple instrument, the Model 200 Air Operated Pycnometer, can be used to accurately determine the true volume of granular plastics or the volume of plastic in bottles, other molded products, or prototypes and should save many hours in determining price weights. The instrument operates in this fashion. The volumes of two equally sized, closed chambers (A, B) of air are decreased the same amount by moving a piston into the chamber of each the same distance. Because the sample of material is placed in one chamber, the volume of air compressed in that chamber is less than in the empty chamber. Since both chambers are at the same temperature, this gives rise to a differential pressure between the two chambers which is read on an indicator. A calibrated auxiliary cylinder and piston (C) connected to the sample chamber is then adjusted to reduce the pressure in the sample chamber by increasing its volume by an amount equal to the sample volume. The movement of the auxiliary piston is converted by the proper gear system to a digital indicator which displays the volume of the sample directly in cubic centimeters. The reading is accurate to within 0.1 cc. Initial sample capacity available 50 or 100 cc. Price $450.00 F.O.B. mfr. Delivery 30 days., *Houston Instrument Corp., P. O. Box 22234, Houston 27, Texas.*

Hot stamping press

For decorating plastic parts using regular foil tapes, this press is designed to operate on 20 to 125 p.s.i. air and is adapted for a **(To page 52)**

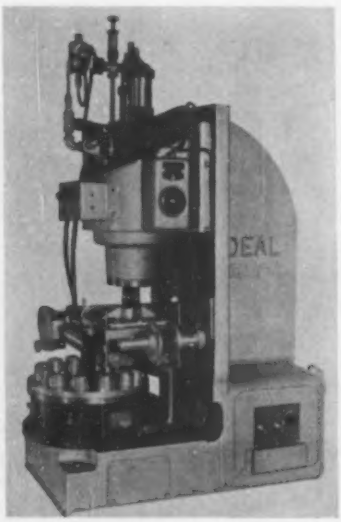
HOUSTON INSTRUMENT Model 200 air operated pycnometer measures volume of granular or solid samples directly and presents volume in figures on dial shown at the far right.



Construction details of the ⅛ in. unit include series 304 stainless steel

(From page 50)

2½- to 8-in. bore air cylinder having a 2- to 6-in. stroke with a maximum pressure of 4800 pounds. Hydraulic control is optional. An electronic dwell control is used with a range of 0.035- to 15-sec. dwell time. The thermostatic temperature control can be varied according to use requirements for operation at temperatures



IDEAL hot stamping press is designed to operate on 20 to 125 p.s.i. air.

between 150 and 450° F. Standard die area is 4 by 6 in., but machine can be supplied with die areas up to 6 by 12 inches. Also included in the design of the machine is a quick change die block and adjustable automatic rotary foil feed with a range of ¼ to 8 inches. Machine requires 115 v-a.c. and it can also be supplied in a 230-v. model. *Ideal Stencil Machine Co., 102 Iowa Ave., Belleville, Ill.*

Indicating temperature control instrument

The series 5000 indicating temperature controller for use on plastic processing equipment features a 10 in. slide rule readout based on a null balance servo system. Temperature control is maintained electronically without depending on the meter movement for control. The temperature indication presents a true readout of temperature of the process being controlled throughout the entire range of the instrument without limiting stops. The instrument is available with either time proportioning or on-off control, with or without anticipating section. Control stability of the proportional model with anticipating section has been achieved to ±0.1° F., and to ±0.5° F. with the On-Off model with anticipation. Indication accuracy is ±½% of scale range. High and low alarm contacts can be provided as an optional feature. The 5000 series control is provided with plug-in plastic encapsulated circuitry. This provides freedom from dust and moisture, insures continued operation under shock and vibration, which permits mounting of the controllers directly on machinery. *Electronic Processes Corp. of Calif., 436 Bryant St., San Francisco 7, Calif.*

Compression press

Originally designed to produce 36 in. high ceramic parts, this unusual 50-ton hydraulic press has an exceptionally long stroke of 78 in. and can be used for the production of long draw plastic parts. Standing 19 ft. high, it has 24 in. between 6-in.-diameter twin columns and 108 in. of daylight. Manually operated, it is powered by a 3-hp. motor with a 7-to-1 booster and has a 50-gal. hydraulic fluid reservoir. Basic machine sells for under $10,000. *The Crossley Machine Co. Inc., Monmouth and Bell Sts., Trenton, N. J.*

Preheater

The Model C6C-P preheater is designed for heating small preforms or loose powder prior to compression or transfer molding. The equipment operates at a frequency of 60 MC. and will heat up to 1 lb. of material on normal cycles. Because of the high frequency, materials with mica filler, melamine, and diallyl phthalate resins can now be handled. Output is 0.75 to 1 kw. with an input of 1.8 kw.-amp. at 120 v., 60-cycle a.c. Platen size is 6 by 6 in. square. The equipment is forced air-cooled, has adjustable platen, timer, and safety switches. Priced under $1000. *Reeve Electronics Inc., 609 W. Lake St., Chicago 6, Ill.*

Miniature heater

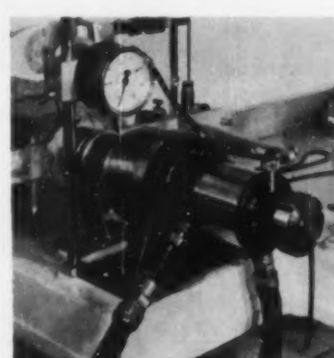
A series of miniature cartridge heaters, ⅛ in. in diameter in any desired length, are designed for applications where space is limited and heat requirements are high. The ⅛ in. units operate at maximum surface temperatures up to 1250° F. Most voltages, including 115 and 230, may be ordered at no extra charge. Construction details of the ⅛ in. unit include series 304 stainless steel sheaths; diameter tolerances of +0.000 in. −0.002 in.; length tolerance ±1/16 in.; heating elements supported on ceramic, packed with magnesium oxide and Teflon-insulated; stranded nickel alloy lead wires. Units may be ordered to any wattage density up to and including the maximum of 50 w./sq. inch. *Hotwatt Inc., 75 Maple St., Danvers, Mass.*

Metallizing wire

Three new tungsten strand coils for vacuum metallizing, two of them with aluminum cores, are now available for immediate shipment. The sizes of the aluminum core coils are 3 by 0.025 in. and 3 by 0.030 inch. The other new coil is 4 by 0.030 inch. New high performance tungsten wire provides superior shot life in vacuum metallizing. Controlled recrystallization of the tungsten produces a uniform flash-over in the vacuum metallizing process. A crystallization rate that is too fast or too slow will cause sagging or brittleness in the wire which can result in premature breakage during reloading as well as in processing. *Sylvania Electric Products Inc., 730 Third Ave., New York 17, N.Y.*

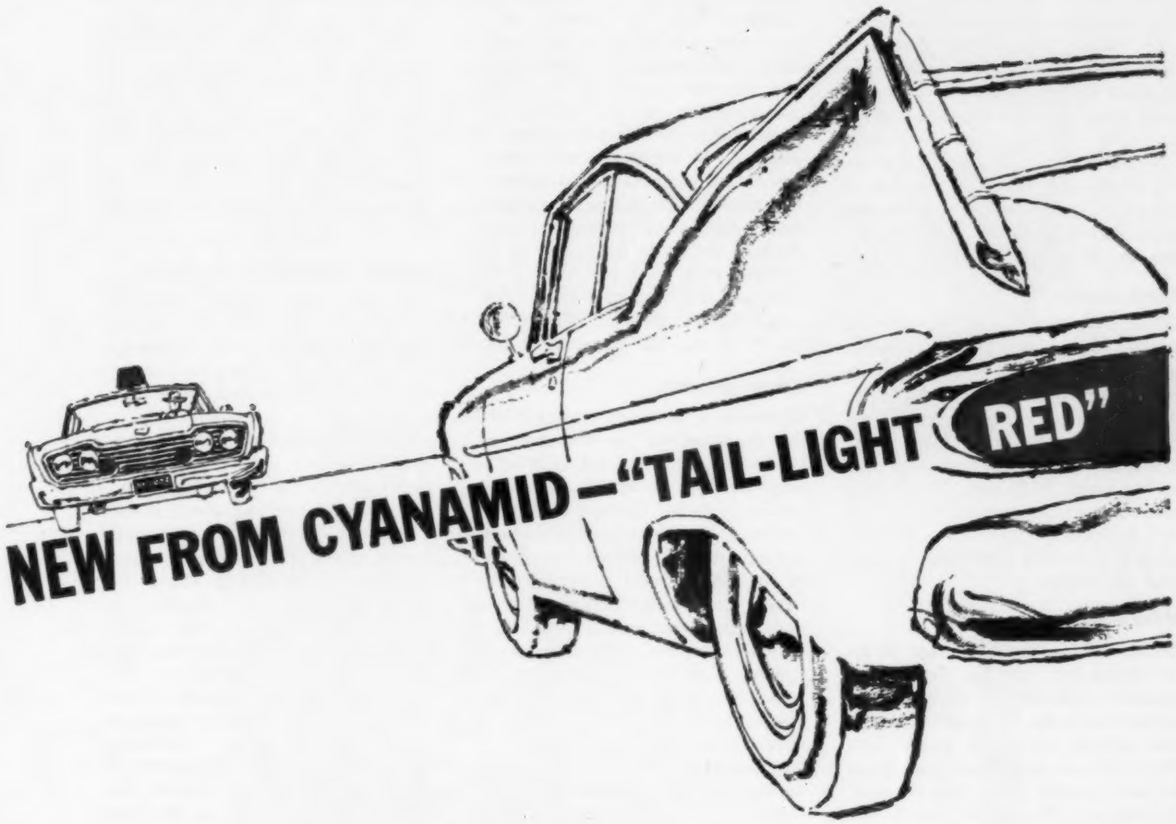
Extruder head

A new extruder attachment for the Plastograph comes with two screws and can be used to measure the work and/or power required to extrude rubber or elastomers with similar properties. The jacket of the new screw attachment can be maintained anywhere up to 200° C. The Plastograph is used for color matching; anti-oxidant and anti- **(To page 54)**



C. W. BRABENDER extruder attachment designed for the Plastograph, showing its use with the basic instrument to measure the degree of power consumption in extrusion operation.

Licencee for European Common Market and Austria ... HENSCHEL-WERKE GMBH KASSEL, W. GERMANY



CALCO® OIL RED ZMQ gives "GO" sign to today's up-to-the-minute thermoplastics!

Here at last—the highly purified Cyanamid version of an old favorite, Anthraquinone Red, "tailor-made" for the thermoplastic market—Calco Oil Red ZMQ. It is unexcelled for tail lights and other signalling equipment, indoors or out ... wherever a clear, bright, absolutely *lightfast* red is of vital importance. Check these advantages: • PURITY—triple recrystallization • CLEANLINESS—less than 50 ppm of heavy metals • SOFTNESS—cuts process time • BRIGHTNESS—higher than current standards • DISPERSION—excellent • For samples, technical counsel—call Cyanamid, dye specialists for the plastics industry since 1937.

NOTE: THE COLOR OF THIS AD APPROXIMATES THE SHADE OF CALCO OIL RED ZMQ.

CYANAMID

AMERICAN CYANAMID COMPANY • DYES DEPARTMENT • BOUND BROOK, N. J.

(*From page 52*)

static studies; also, polymer stability analysis, determination of graft sites and molecular weights. Available with special mixing blades which are suitable for all the newest materials and their elevated temperatures, it shows flow index values under production conditions. Rheological studies of flow performance can also be made. *C. W. Brabender Instruments Inc., 50 East Wesley St., South Hackensack, N. J.*

Gate cutter

Measuring only 6½ in. in over-all length, gate cutter has sharply ground knife edges with flat backs for close cutting of plastics only. The cutters are of IMS design and West German manufacture. They have blades almost 1 in. long and leaf spring action, $3.75 each. This brings IMS's line of gate cutters to five different models. *Injection Molders Supply Co., 3514 Lee Road, Cleveland 20, Ohio.*

Process heater

Designated as Type PF, this series of automatic electric fluid heat transfer systems is designed for simple hook-up to revolving rolls and platens, dies and molds, and other process equipment. All types of heat transfer fluids can be used. It includes a Chromalox electric immersion heater, motor and high-temperature pump, by-pass relief valve, strainer, expansion tank, temperature controls, contractors, and disconnect switches. All of this equipment, mounted on a steel base with protective grille enclosure, takes only 6 square feet for smaller models, 12 square feet for larger models. Temperatures may be selected and accurately controlled anywhere from 100 up to 600° F. Built-in controls eliminate explosion or fire hazard. Ten models are available in both standard and special voltages and phases. Wattage ratings range from 4.5 to 80 kw., with B.t.u. output from 15,350 to 272,000. *Radcor Inc., 7500 Thomas Boulevard, Pittsburgh 8, Pa.*

Moisture analyzer

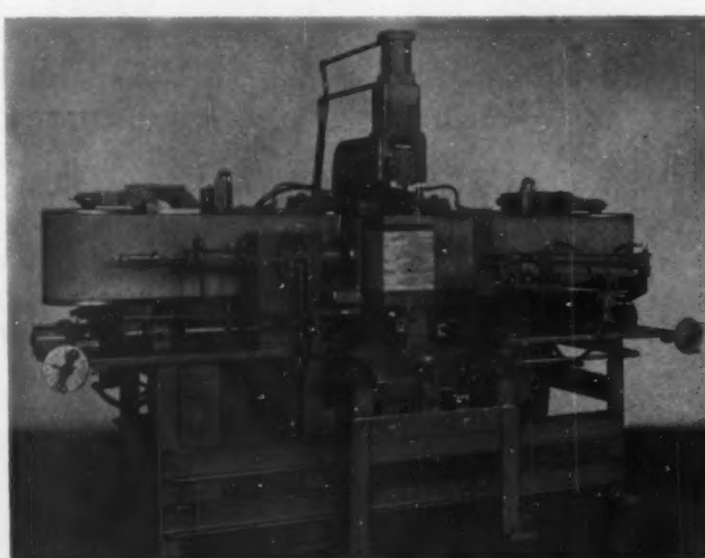
Plastic processors using hygroscopic materials such as nylon or cellulosics, should find the Model HFS-4E moisture meter most useful. This instrument detects the presence of up to 70% moisture to an accuracy of 0.1% or better by measuring the dielectric loss caused by this moisture. Moisture measurements are made in a matter of seconds by filling a cup electrode with the material to be measured, placing it on the instrument, and reading the moisture content directly in percents. Continuous measurements can be made by incorporating the proper design of electrode in the production equipment. The instrument does have to be calibrated for the particular material with which it is to be used. Normal variations in density of the material or granule size have no effect on the measurement. Price: about $1,900. *Boonton Polytechnic Co., P. O. Box 125, Boonton, N. J.*

Edge grinder

Known as a "precision edge grinder," this machine can be used for high production squaring and finishing of vinyl floor tile, laminates, and similar plastic products. Corners of finished products are sharp and edges are ground parallel and square. Blocks of material, or work piece, pass between the two oscillating, abrasive belts, index, and then return. Finish depends upon the abrasive belt used, and machines are available for use with any desired belt width. Machine may be set up to allow the blocks of material to make several passes before indexing. The production rate depends on the material and finish desired. A typical rate measured on terra-vinyl and vinyl asbestos floor tile was two to three 10-in. stacks per minute. Tolerances maintained were within 0.001 in. on squareness, and parallelism of the 10-in. stack was within 0.0015 inch. For higher production rates, machines may be arranged in tandem, with indexing to suit the operation. Loading may be manual or automatic. Traverse of the work is hydraulically controlled and can be operated by hand or automatically cycled. Carrier and heads are mounted on hardened and ground, boot-protected shafts. Machines can be supplied that are modified to the customer's specific requirements. *Murray-Way Corp., P. O. Box 180, Birmingham, Mich.*

Static electricity detector

The electrostatic locator—Type E—detects electrostatic charges by electrostatic induction. The presence of such charges in industrial processes can constitute a serious fire and explosion hazard and frequently introduces production difficulties by causing erratic behavior of certain materials during processing. Pointing the probe of the meter toward a charged object, will cause a meter needle to deflect. The linear scale of the meter is graduated —10, 5, 0, 5, 10+, indicating the polarity and relative magnitude of the charge. Three sensitivity ranges of the meter are provided by adjustment of apertures built into the probe. Where more precise quantitative measurements are required, calibration charts are used to determine the actual voltage on the charged material. Voltages as low as 50 v. and as high as 40,000 v. can be measured. Power is supplied by one standard flashlight cell and **(To page 178)**



MURRAY-WAY precision edge grinder shows the machine square-grinding a stack of vinyl asbestos floor tile.

There's always a job for a Wood Press . . . and a Wood Press to do the job

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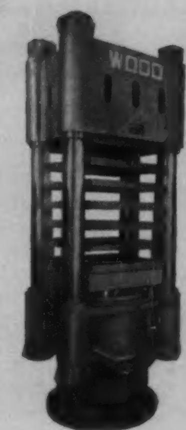
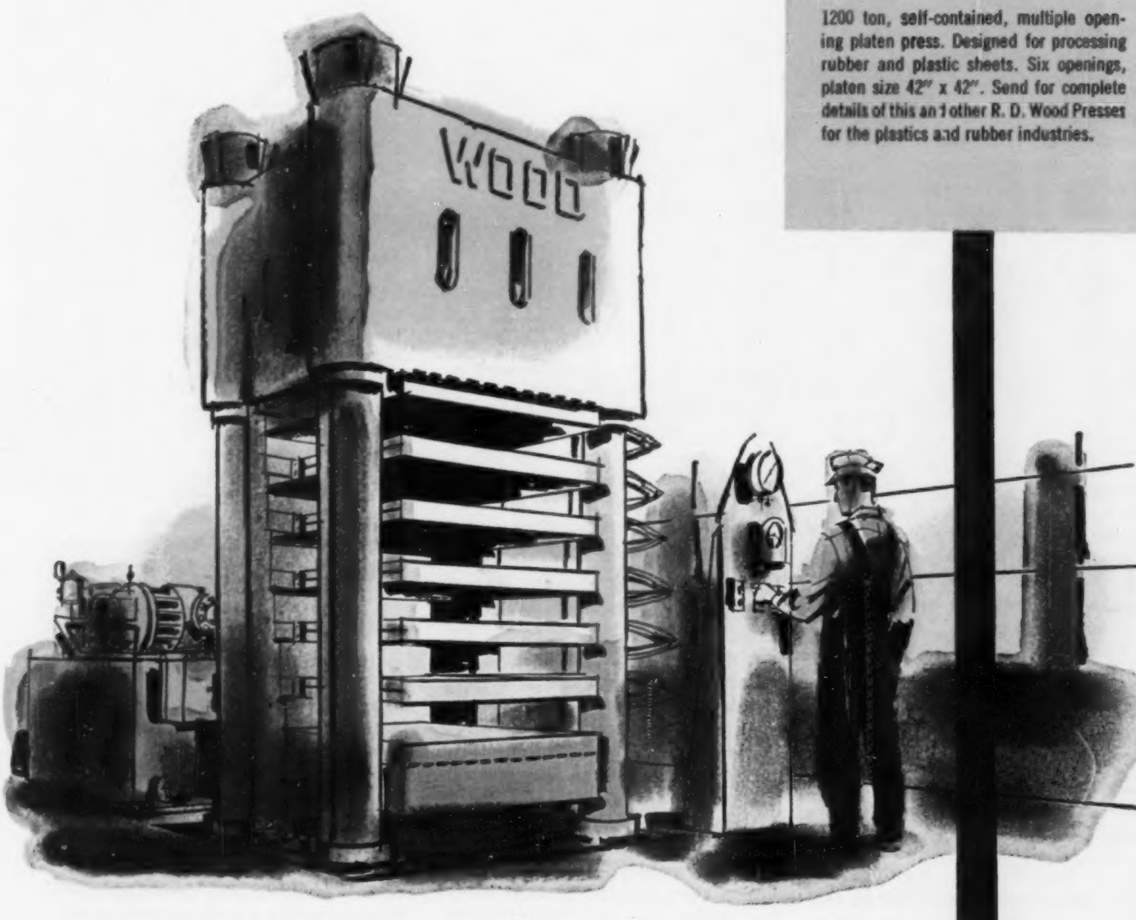


1200 ton, self-contained, multiple opening platen press. Designed for processing rubber and plastic sheets. Six openings, platen size 42" x 42". Send for complete details of this and other R. D. Wood Presses for the plastics and rubber industries.



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WORLD-WIDE PLASTICS DIGEST*

Abstracts from the world's literature relative to plastics. For complete articles, send requests direct to publishers. List of addresses is at end of this section.

General

Crystals guide film quality. Chem. Eng. News *38*, 38-39 (Feb. 1, 1960). A new process for producing polymorphous polyethylene film gives greater clarity, higher impact resistance, and greater resistance to tear than present films.

Unsaturated polyesters. J. E. Sayre and P. A. Elias. Chem. Eng. News 37, 56-62 (Dec. 21, 1959). Production figures, makers, uses by categories, and applications of polyester plastics are discussed.

New question in plastics. Chem. Week *86*, 23-24 (Mar. 5, 1960). Potential production and uses of polyformaldehyde plastics is dependent on the rate of decrease in price. Several domestic and foreign manufacturers are considering this new plastic material.

Classification of high polymer materials. O. Leuchs. Kunststoffe *50*, 10-13 (Jan. 1960). In Germany, Austria, Holland, and Switzerland the word "kunststoff" is used to designate synthetic resins; in other countries the term "plastics" derived from the word "plastic" (i.e., pliable, flexible) is used. Objection can be raised against both these terms when they are applied to all high polymer materials. The suitability of the two terms and the further development that may occur in the classification of these materials are considered as well as discussed.

New heat on high-temperature polymers. Chem. Week *86*, 57-58, 60 (Mar. 12, 1960). The goals of government contracts with chemical manufacturers to develop new polymers that are heat-resistant up to 1000° F. are reviewed. The chemical compounds that are being considered are discussed.

New epoxy entry. Chem. Week *86*, 32-33 (Feb. 13, 1960). Epoxidized polyolefin resins are easy to cure and have low density and good high temperature properties.

New plastic coat shrugs off heat. Chem. Eng. News *38*, 54, 56 (Mar. 28, 1960). A plastic coating effective at temperatures up to 6000° F. is composed of inorganic phosphates and borates in a polyurethane. On heating it foams and melts forming a hard ceramic-like crust.

Fluorocarbon studies lead to high temperature polymers. Space/Aeronautics 32, 109, 111, 113 (Dec. 1959). Research at the National Bureau of Standards on aromatic fluorocarbons that are expected to yield radiation and high-temperature resistant plastics is summarized.

Materials

Vinyl hydrosols. W. A. Riese. Kunststoffe *50*, 83-84 (Jan. 1960). Vinyl hydrosols are defined as redispersed systems of polyvinyl chloride, plasticizers, fillers, and pigments, as well as processing aids, in water systems which, possibly with the help of added thickening agents, are homogeneous dispersions with Newtonian viscosity behavior. With a solids content of 55 to 65%, hydrosols resemble plastisols in their processing characteristics and application, but differ from the latter in that they are able to take up more filler than plastisols. Typical formulations are given.

Multiaxially stretched low-pressure polyolefin film. K. Richard, G. Diedrich, and E. Gaube. Kunststoffe *49*, 671-78 (Dec. 1959). The characteristics and behavior of low-pressure PE and polypropylene films multiaxially stretched are reported.

Low-pressure reinforced plastics. M. W. Riley. Materials in Design Eng. *51*, 103-18 (Feb. 1960). Materials, molding methods, and design data are considered. The four basic families of resins used for low-pressure reinforced plastics are the polyesters, epoxies, phenolics, and silicones. In addition to fibrous glass and many of the synthetic fibers, graphite textiles and metal fibers have found some uses. The low-pressure molding processes commonly used include contact molding, bag molding, autoclave, matched die, filament winding, and spray molding. Glass content, laminate thickness, and orientation of the glass filaments are all important variables that influence the properties of the completed structure. Reinforced plastics are sensitive to duration of loading. Tensile creep at room temperature appears to be negligible, both parallel and perpendicular to the warp. Strength, stiffness, fatigue, and impact properties of glass-reinforced plastics tend to increase with decreasing temperature. In general, the dielectric constant and loss tangent decreases with increasing frequency above the very high frequency range.

Use of reground glass-filled polystyrene. G. R. Rugger. SPE J. *15*, 1053-54 (Dec. 1959). A test program was established to study the feasibility of using reground glass-filled polystyrene in meeting certain military specifications normally requiring 100% virgin material. The results indicate that up to 30% coarsely ground material can be added with the product still capable of passing the drop impact test. Laboratory results for tensile strength and Rockwell M hardness correlate with end item suitability.

Molding and fabricating

Continuous forming of thermoplastic sheet by a rotational deep drawing method. G. Missbach. Kunststoffe *50*, 140-42 (Feb. 1960). A continuous process for vacuum forming parts from sheet plastics is described. The process is a revolving drum type.

Fully automatic insertion of metal parts. K. Wopalka. Kunststoffe *50*, 142-45 (Feb. 1960). The design and construction of a twin-impression injection mold used to insert brass wire into a plastic molding speeds up considerably the incorporation of metal inserts.

Fluidized bed: Heavy coatings in one dip. W. R. Pascoe. Materials in Design Eng. *51*, 91-95 (Feb. 1960). The parts to be coated are preheated to a temperature above the melting point of the plastics coating material. The preheated parts are immersed in a fluidized bed of finely-divided plastic powder. The powders are fluidized by an ascending current of gas or air. The part may be post-heated to completely coalesce the coating. Coatings from 5 to 50 mils thick can be produced in a single dip. Coatings obtained with this process are uniform and of high quality. The process is well suited for applying solvent-resistant materials such as nylon. The mechanical, electrical, **(To page 58)**

*Reg. U. S. Pat. Off.

PLASTICS DIGEST

(From p. 56)

and thermal properties, chemical resistance, and applications of six types of coatings are given. These include cellulosic, vinyl chloride, epoxy, nylon, polyethylene, and chlorinated polyether coatings.

Applications

Evaluating polyethylene films for agriculture. V. L. Gliniecki. Down to Earth *15*, 7-9 (Winter 1959). The properties of polyethylene films that are needed to evaluate their usefulness in agricultural applications are reported. These include weatherability, soil temperature buildup, moisture retention, weed control, and gas transmission. The black films give the best weatherability. Increasing the thickness also increases weatherability. Soil temperatures are higher, moisture retention is improved and gas retention for fumigants is excellent when the film is used as a general cover. Black film is needed for weed control.

Laying plastics floor coverings. E. Fortun. Kunststoffe *50*, 137-40 (Feb. 1960). Principal requirements that are necessary for laying plastic flooring are summarized.

Plastics in building. Plastics Inst. Trans. and J. *28*, 4-48 (Feb. 1960). Seven symposia papers. "Nature, properties, and uses of plastics," by C. W. Welch, pp. 4-12. The structure, properties, methods of processing, prices, and design criteria of plastics are reviewed briefly from the viewpoint of their use in building. The properties are compared with those of other construction materials. "Operations," by S. Greenwood, pp. 12-18. Problems concerned with forming plastic building parts are discussed. "Construction," by D. S. Mahon, pp. 19-26. The uses of plastics as primary structural components, as secondary structural components, and in decoration and fittings are considered. "Plastics as components in dome and roof structures," by Z. S. Makowski, pp. 26-29. Dome and roof structures made of fiber-glass-reinforced polyester plastics and of conventional materials covered with vinyl chloride plastics and neoprene, are described. "Services," by W. L. Thorne, pp. 30-36. Plastics used in sound insulation, water pipes, drainage systems, heating and lighting systems, guttering, soffit and fascia boards, and gas mains are described. Data are also given on installation and maintenance costs. "Thermal insulation," by W. B. Brown, pp. 36-44. The uses of cellular plastics in building construction for thermal insulation are described. The properties of these materials are given and compared with other insulating materials. "Performance and aesthetics," by G. K. Frindlay, pp. 45-48. The uses of plastics in bathtubs, wall tiles, window frames, and suspended ceilings are described.

Unveiling the newest plastic package. Chem. Week *85*, 195-96, 198 (Nov. 21, 1959). A process for making boxes from biaxially oriented polystyrene sheet by a cold-forming operation is described.

Properties

Characterization of polyolefins by differential thermal analysis. B. Ke. J. Polymer Sci. *42*, 15-23 (Jan. 1960). Differential thermal analysis was used to study the solid-liquid transitions of four polyethylenes, an isotactic polypropylene, a series of ethylene-propylene copolymers, and a physical mixture of polyethylene and polypropylene. The thermograms obtained directly yield the transition temperatures. By calibration, heats and entropies of fusion were also derived from the thermograms. From the heats of fusion, the degree of crystallinity of these polymers was calculated. Differential thermal anlysis can detect a physical mixture of polymers that melt sufficiently wide apart. The thermogram-peak areas are proportional to the amounts of material present. Convenience and speed make differential thermal analysis a useful and practical tool for characterizing polymeric materials when uniform conditions are maintained.

Influence of fillers on the structure and electrical properties of plasticized PVC compounds. M. Kreiss. Kunststoffe *49*, 679-83 (Dec. 1959). Electrical measurements show that fillers added to plasticized PVC tend to absorb plasticizer. Fillers also absorb saponification products and thus improve electrical values. Results of measurements of tan δ, the loss angle, as well as stability, electrical, and water storage experiments indicates that the filler particles, which differ in size, are embedded randomly in the tangled PVC molecules. The size of the individual filler particles, whose surfaces are split, is roughly the same as that of a PVC thread molecule. The forces of attraction between the filler particles and their surroundings are very small. The remaining spaces, about 10^{-7} cm., have no connection if the filler content is low and filler distribution is even.

Dielectric properties of linear polyamides. D. W. McCall and E. W. Anderson. J. Chem. Phys. *32*, 237-41 (Jan. 1960). The dielectric relaxation of several linear polyamides was measured to study the nature of the molecular motion of the polymers. The materials are of special interest because of the great strength of their interchain forces. The amorphous portions of these polymers are primarily responsible for their dielectric properties. Amide protons carry direct current and are responsible for the low-frequency loss. Dipole relaxation is the important loss mechanism at high frequencies and elevated temperatures. Relaxation occurs in dielectric loss and proton resonance studies, indicating movement of both the dipolar and paraffinic components of the molecule, even at low temperatures.

Structure and properties of metals, glass, and plastics. K. H. Hellwege. Kunststoffe *50*, 3-10 (Jan. 1960). A comparison of metals and plastics shows, from the point of view of the physicist that they are similar. It seems that plastics will in future prove to be crystals with the highest degree of disorder or liquids with the highest degree of order. Analysis of structural elements as well as elementary processes is one of the most important tasks that is facing plastics research.

Testing

Physical methods of testing plastics. A. J. Staverman and J. Heijboer. Kunststoffe *50*, 23-26 (Jan. 1960). Present methods of test are unable to measure all the important mechanical properties of plastics. Scientific research will lead to new ways of testing plastics.

Hardness, abrasion, and wear resistance testing of plastics. L. Boor. ASTM Bulletin *244*, 43-47 (Feb. 1960). Methods for measuring hardness, abrasion, and wear resistance of plastics are reviewed, compared, and evaluated. 18 references.

Improved NBS abrasive jet method for measuring abrasion resistance of coatings. A. G. Roberts. ASTM Bulletin No. 244, 48-51 (Feb. 1960). A description is given of improvements made in the NBS Abrasive Jet Method since pub- **(To page 184)**

U.S. PLASTICS PATENTS

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 25¢ each.

U.S. Pats., Feb. 16, 1960

Printing on plastic. W. E. Hastings (to National Dairy). 2,924,923.

Heat sealing. W. Jaquiery (to Chippewa Plastics). 2,925,119.

Tank of reinforced resin. J. F. Gibb (to National Tank). 2,925,193.

Tappable container. J. W. Brookshier (to B-Line Dispensers). 2,925,199.

Polyolefin composition. A. Y. Coran and H. L. Merten (to Monsanto). 2,925,398.

Elastomeric copolymer. P. Schneider, G. Scriba and W. Graulick (to Bayer). 2,925,399.

Polyolefins. C. E. Tholstrup, A. Bell, G. C. Newland, J. W. Tamblyn, and C. J. Kibler (to Eastman Kodak). 2,925,400-1.

Polyepoxides. E. C. Shokal (to Shell). 2,925,403.

Copolyesters of a dicarboxylic acid. J. R. Caldwell and J. W. Wellman (to Eastman Kodak). 2,925,404.

Polyesters. T. M. Laakso and J. L. R. Williams (to Eastman Kodak). 2,925,405.

Polythioalkylacrylates. R. M. McCurdy and J. H. Prager (to Minnesota Mining). 2,925,406.

U.S. Pats., Feb. 23, 1960

Surface hardening. J. Mahler (to American Optical). 2,925,622.

Plastic window pane. K. Sundby. 2,925,862.

Edge-heating thermoplastic dielectrics. W. Rueggeberg (to Armstrong Cork). 2,925,864.

Shrinkproofing oriented polyethylene. M. J. Coplan, R. J. Coskren, and T. T. Constantine (to Fabric Research). 2,926,065.

Paper-containing polyamide suspensoid. H. W. Hooff (to General Mills). 2,926,117.

Graft copolymers. R. K. Graham and M. S. Gluckman (to Rohm & Haas). 2,926,126.

Phosphono-polyesters. R. L. McConnell and H. W. Coover Jr. (to Eastman Kodak). 2,926,145.

Polyisocyanate composition. G. Rappaport, J. A. Szaruga, and J. R. Wall (to General Motors). 2,926,147.

Cumylphenol - phenol-formaldehyde resin. F. Backer (to Allied Chemical). 2,926,149.

Thermal stabilization of haloethylene polymers. D. A. Gordon (to Dow). 2,926,152.

Polyamide-epichlorohydrin resins. G. I. Keim (to Hercules). 2,926,154.

Chlorinated polyolefins. J. S. Tinsley (to Hercules). 2,926,159.

Diallyl amine polymers. G. B. Butler, R. J. Angelo, and A. Cranshaw (to Peninsular). 2,926,161.

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Foam structures. W. D. Garlington (to Du Pont). 2,926,389.

Release coating. C. W. Wilkins (to Owens-Illinois). 2,926,829.

Photopolymerizable compositions. E. L. Martin and A. L. Barney (to Du Pont). 2,927,022-3.

Atactic polypropylene. F. Schulde, W. Sommer, and D. Schleede (to Lucius & Bruning). 2,927,047.

Triazine-formaldehyde resins. A. Hiestand and O. Albrecht (to Ciba). 2,927,090.

Polystyrene phonograph record. E. A. Naudain and A. L. Rummelsberg (to Hercules). 2,927,092

Polyvinyl chloride composition. W. M. Germon (to Goodyear). 2,927,093.

Epoxy resins. C. E. Wheelock (to Phillips). 2,927,094.

Phenolic resins. R. L. Von Berg and N. I. Poffenberger (to Dow). 2,927,097.

Block copolymers of N-vinyl pyrrolidone. J. W. Breitenback and H. Edelhauser (to W. R. Grace). 2,927,102.

Polyisobutylene. A. B. Small and J. L. Ernst (to Esso). 2,927,104.

Polyethylene. H. Nienburg, G. Schiller, H. Weber, and H. Boehm (to Badische Anilin). 2,927,105.

Polyethylene. H. J. Hepp and E. O. Box Jr. (to Phillips). 2,927,106.

U.S. Pats., Mar. 8, 1960

Packaging fluid in plastic bags. L. Doyen and L. Doyen. 2,927,410.

Plastic drive fastener. G. M. Rapata (to Illinois Tool). 2,927,497.

Laminating machine. A. F. Elliott. 2,927,620.

Cellular core. P. Hoppe and H. W. Paffrath (to Bayer and Mobay). 2,927,876.

Fluorochloro polymer. D. E. Neunherz (to Minnesota Mining). 2,927,-893-4-5.

Expanded polyurethane. C. F. Eckert (to U. S. Rubber). 2,927,905.

Fluorinated organopolysiloxanes. G. M. Konkle and T. D. Talcoff (to Dow Corning). 2,927,908.

Masonry water-repellent coating. J. D. Lyons and B. C. Carlson (to Dow Corning). 2,927,909.

Phenolic-organosiloxane cements. R. H. Cooper (to Dow). 2,927,910.

N-vinyl lactam polymers. F. Grosser (to General Aniline). 2,927,913.

Vinyl ether polymers cross-linked with iodine. W. A. Hosmer and A. C. Starke (to General Aniline). 2,927,-914.

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Curing of polyepoxides. W. J. Belanger and H. G. Cooke Jr. (to Devoe & Raynolds). 2,928,794.

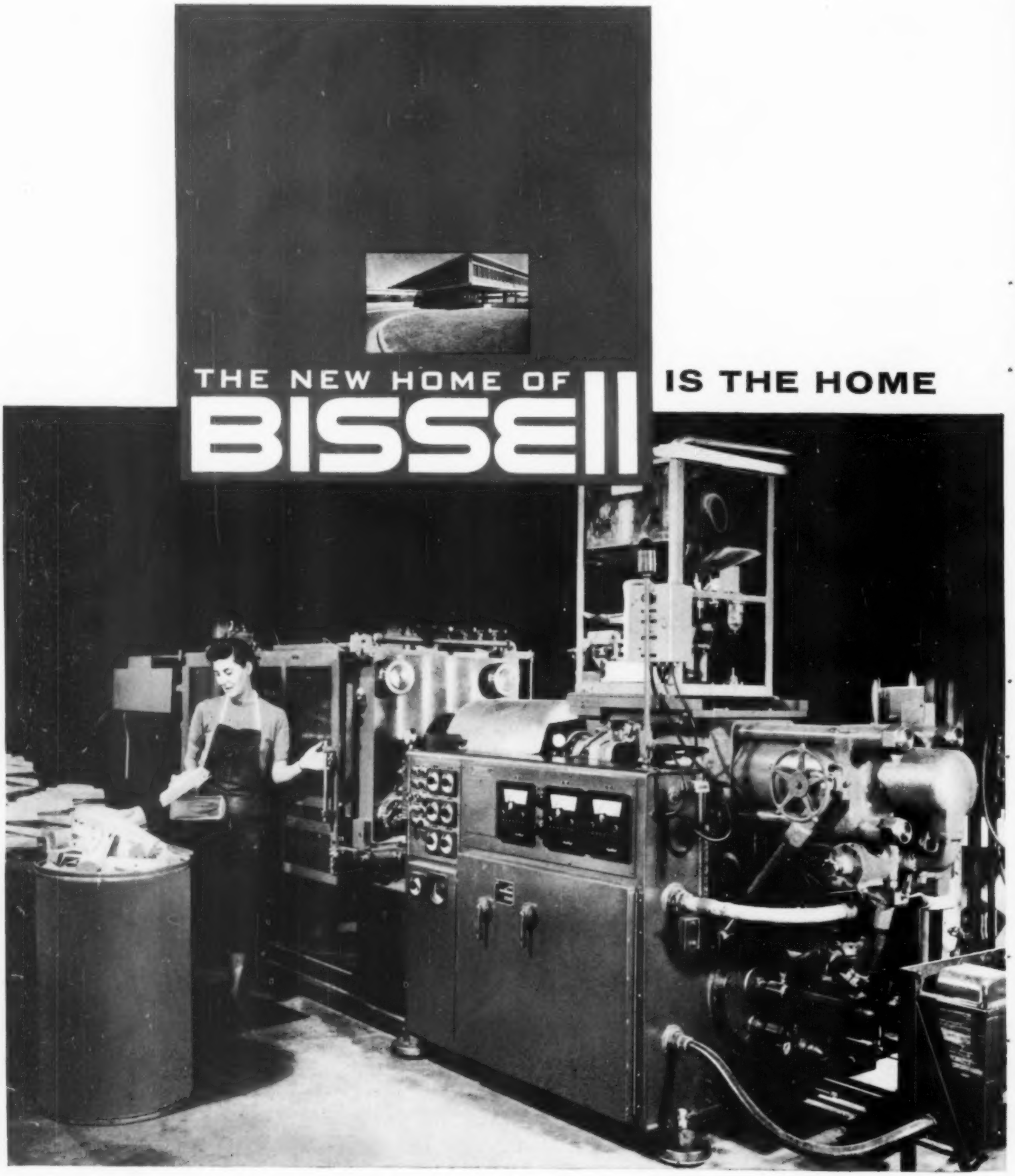
Molding composition. J. S. Tinsley (to Hercules). 2,928,795.

Polymer composition. J. Rehner Jr., H. K. Wiese, and A. M. Gessler (to Esso.) 2,928,802.

Curing polyepoxides. W. J. Belanger and H. G. Cooke Jr. (to Devoe & Raynolds). 2,928,803.

Curing polymerizable esters. G. L. Foster and P. F. Nicks (to Imperial Chemical). 2,928,804.

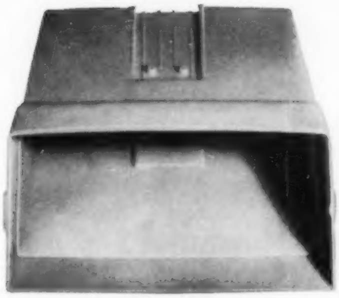
Silicone - acrylonitrile copolymers. D. L. Bailey and R. M. Pike (to Union Carbide). 2,928,806.—End



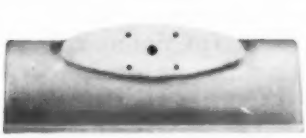
IS THE HOME

Fellows

injection molding equipment



OF SIX FELLOWS NO. 12-350 MACHINES



Here's a plant where the functional beauty of the exterior is matched by the efficiency of the production equipment inside.

In the manufacture of its high-quality line of home-cleaning equipment, Bissell, Inc., Grand Rapids, Michigan relies on six Fellows No. 12-350 injection molding machines to produce difficult-to-mold parts at high production rates.

The fully-automatic Fellows No. 12-350 machine, with all controls grouped for easy reading, dry cycles at 600-800 per hour.

Its standard Pre-Pac device double-strokes the plunger during press dwell, permitting shots up to 20 ounces (33 cubic inches).

The Fellows No. 12-350 machine is easy to set up, and requires so little supervision that one operator can often handle three or more machines at the same time.

Find out how Fellows can help you to handle even your toughest molding jobs. Get in touch with your Fellows representative.

THE FELLOWS GEAR SHAPER COMPANY *Plastics Machine Division,* Head Office and Export Department, Springfield, Vermont
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U.S.I. POLYETHYLENE NEWS

A series of advertisements for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

Packaging Notes

Molded polyethylene containers which can be hermetically sealed by automatic packaging machines are now available for frozen or chilled foods. The semi-rigid containers are reported to be useful for many applications where plastic has heretofore been inadequate due to problems of leakage or dehydration. After the containers are filled, polyethylene film is heat sealed around the reclosable lids, thus hermetically enclosing the contents of the package. A convenient pull tab is provided for initial opening.

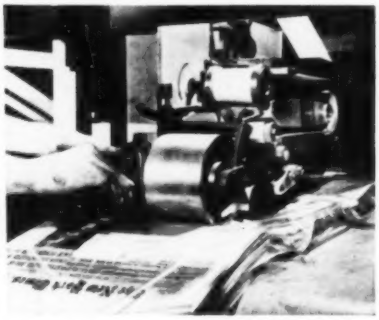
The containers are currently produced in pint and half-pint sizes. They are supplied in from one to four colors or can be left with a clear background for product visibility.

The manufacturer claims the polyethylene containers offer shipping and handling economies because they are lightweight and unbreakable.

Safety snap-on caps which fit tightly over medicine bottles, are a recent polyethylene development. They make it virtually impossible for children to get at the bottle's contents, yet adults can easily remove the caps with a flick of the thumb. The closures are said to stay secure no matter how often they're used.

Newspapers in heat-sealed polyethylene bags are now being mailed to suscribers for the first time, reports a metropolitan publisher.

Copies of the paper's Sunday edition are bagged at the rate of 1,500 per hour, using semi-automatic baggers and a continuous heat sealer. A special machine handles rolls of pre-addressed labels, coated on the reverse side with a thermoplastic adhesive.



Roll stock, pre-printed with subscriber's name and address, is automatically heated, cut, indexed and placed on the bags by the labeling attachment. The thermo-plastic coating of the label adheres firmly to the polyethylene bag.

The pre-formed 14 x 19½" polyethylene bags permit copies to be shipped flat, facilitating handling, stacking and shipping.

Newspaper officials report that the 1.5 mil polyethylene bags protect papers against rough handling, soiling, tearing and weather. They agree that the improved appearance of the paper should have an influence on customer re-orders of mail subscriptions.

U.S.I. Introduces Three New Polyethylene Blow Molding Resins

New PETROTHENE Resins Produce Bottles of Excellent Appearance, Are Easy to Process

U.S.I. has developed three new PETROTHENE polyethylene resins with properties particularly suited to individual blow molding requirements. Two of the resins can also be used for injection molding. All have been evaluated by U.S.I.'s Polymer Service Laboratories and have been successfully field tested.

PETROTHENE 101 and PETROTHENE 102-2 can be used in both blow molding and injection molding, the first in applications requiring high stiffness and good stress crack resistance, the second in applications where stiffness and impermeability to liquids, oils, and gases is important. PETROTHENE 209-2 is designed for use in blow molding, especially for relatively small moldings with thick side walls.

Each of the resins is easy to process and produces bottles of outstanding appearance, good stress crack resistance and excellent low-temperature flexibility.

Lower Cost Per Container

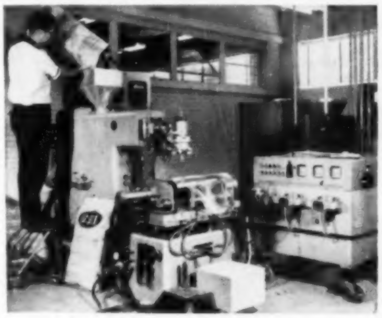
High stiffness and good stress crack resistance are the key characteristics of PETROTHENE 101 (density–0.924, melt index–2.0). This permits a reduction in wall thickness and consequently, a lower cost per container. Its torsional modulus of elasticity is approximately 18,000 lb/sq in. higher than the best of three other similar polyethylene resins commonly used for blow molding.

The stress crack resistance of PETROTHENE 101 was tested in an accelerated shelf-life test by filling thin-wall tubes molded of the resin with a commercial detergent and holding them at 120°F for 4 months. There were no container failures even though the metal closures were beginning to show signs of corrosion.

Carboys For Chemicals

High flow rate is the key characteristic of PETROTHENE 102-2 (density-0.924, melt index-2.0). This makes the resin particularly useful in blow molding pieces 6 to 20 oz. or heavier.

Because PETROTHENE 102-2 is also highly impermeable to liquids, oils and gases, it is a desirable resin for blow molding large carboys for liquid chemicals. However, normal precautions should be observed in producing containers for chemicals which act as stress cracking agents.



Extrusion blow molding machine in operation at U.S.I.'s Polymer Service Laboratories, used for evaluating the new PETROTHENE molding resins.

Small Bottles a Natural

The excellent low-temperature flexibility of PETROTHENE 209-2 (density 0.920, melt index-3.0) makes it ideal for bottle blowing where the moldings are relatively small—under 10 oz.—and have thick sides. Its stress crack resistance is comparable to that of competitive resins used for the same applications. In field evaluations, cycle times with this resin were found to be faster than those of comparable resins. Yet seal strength at the parison pinch-off point—often a problem when blow molding cycles are shortened—is good.

Data Available On Silk Screen Printing Machines

A manufacturer of machines for direct printing on polyethylene bottles and other containers is offering a brochure describing the company's line of equipment. The machines, which are automatic and semi-automatic, can print on flat, cylindrical and conical surfaces, and even on objects of awkward shapes. Multicolor printing is possible by printing one color and allowing it to dry before applying the next.

New Twin-Station Machine For Versatile Blow Molding

A new twin-station blow molding machine which permits simultaneous operation with either identical or different molds has been developed. For example, a toy can be blown in one station at the same time a two-quart bottle is being blown in the second station.

The machine's capacity is large, accommodating molds up to 36" by 21" wide and 28" daylight with a 12" stroke. Equipment is said to be safe, simple and low in cost to operate and maintain.

exceptional moisture and grease resistance

POLYETHYLENE-COATED KRAFT OPENS UP NEW OPPORTUNITIES FOR CORRUGATED BOARD

Polyethylene-coated corrugated board — produced on conventional corrugating equipment — is extending the usefulness of corrugated into many new packaging applications.

This unique container board has exceptional moisture and grease resistance and a glossy, non-abrasive liner surface that will not scratch or mar package contents.

Extruders who produce polyethylene-coated kraft liner board can get these extra advantages by using U.S.I. PETROTHENE® polyethylene resins:

HIGH PRODUCTION RATES—PETROTHENE resins have good drawdown properties, permit extrusion at high speeds.

EXCELLENT ADHESION — with minimum hot melt oxidation.

NO ODOR — an important consideration in many packaging applications.

Contact U.S.I. for information on PETROTHENE resins especially suited for coating kraft liner board.

Packagers are investigating polyethylene-coated corrugated board for applications like these:

Bulk shipment of meat, where moisture and grease-proof interiors reduce weight loss of the meat and keep moisture from weakening the carton.

Shipment of furniture and other hard goods, where abrasion damage from the container has been a problem.

Bulk bakery and confectionery shipments, where absence of grease-wickage makes containers suitable for reuse as point-of-sale displays.

In concrete construction forms, where the polyethylene coating acts as a release agent.

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corp.
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Branches in principal cities

POLYETHYLENE PROCESSING TIPS

Series V, No. 3

FACTORS AFFECTING ADHESION IN EXTRUSION COATING

In the polyethylene extrusion coating process, the nature of the bond between coating and substrate can be chemical, physical or a combination of both. Chemical bonding is involved almost exclusively when the substrate is a non-porous material such as foil or cellophane. With porous substrates such as paper or board stock, physical as well as chemical bonding takes place.

Physical bonding results from the absorption of the molten polymer by the substrate pores. The degree of adhesion is primarily a function of the polyethylene melt index and the surface characteristics of the substrate.

Resins of lower viscosity, which flow more freely, bond more firmly than do higher viscosity resins. The more porous the substrate, too, the better the physical bond will be.

Oxidation Improves Chemical Bonding

Chemical bonding depends on the number of carbonyl (CO) groups on the coating surface at the moment of contact with the substrate. Since carbonyl groups are formed by oxidation of the polymer, conditions which promote oxidation generally result in improved adhesion.

Heat has the greatest effect on oxidation; hence, stock temperature control is important. Figure 1 shows that increasing stock temperature produces an increase in carbonyl groups on the polymer surface. Figure 2, the curve showing the effect of stock temperature on adhesion, is almost identical.

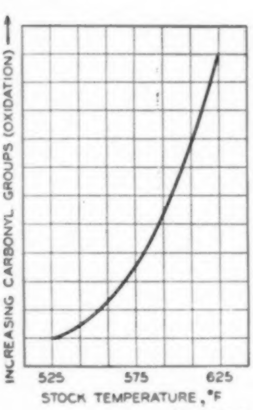

FIGURE 1

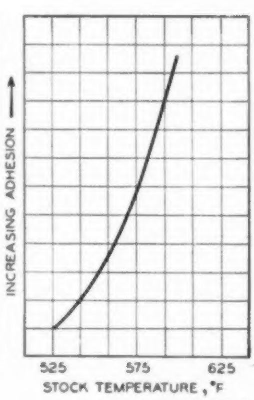

FIGURE 2

A minimum stock temperature of 575°F. is necessary for adequate adhesion in most operations. This value is based on extensive research in the Polymer Service Laboratories of U.S.I. As a rule, temperatures above this are recommended.

The operator, however, must not work at temperatures high enough to cause excessive oxidation. If he does, the polymer will be degraded badly and its heat sealability impaired. Using the above minimum value as a guide, he must determine for each application a stock temperature that will give maximum adhesion without serious degradation.

Controlling Coating Temperature

Several other operating variables affect oxidation of the polymer. Increasing the coating speed allows less time for oxidation to occur, and therefore decreases adhesion. Conversely, heavier coating weights improve adhesion by slowing the cooling time of the molten web. Preheating the substrate has the same effect.

Adjusting Coating Equipment

One measure of coating quality is uniformity of adhesion across the entire width of the substrate. This can be achieved only by careful alignment of the extrusion coating equipment. Chill and nip rolls must be parallel in the same horizontal plane, and the die must be in a plane parallel to the nip.

Pressure applied by the rubber pressure roll should be uniform across its width. And excessive pressure should be avoided since it contributes little to bond strength.

Picking the Right Resin

Good adhesion also depends on the choice of the right resins. Many resins that are excellent for film extrusion, for example, are not quite so good for extrusion coating. U.S.I. has developed the following series of "Petrothene"® resins specifically for the coating process. These resins have excellent coating characteristics and their oxidation is easy to control.

PETROTHENE® Resin	Melt Index	Density	Recommended Coating Weight (Lbs. per 3000 sq. ft.)
200-2	3.0	0.915	20 and higher
201-2	5.0	0.915	10 to 25
203-2	8.0	0.915	3 to 15

U.S.I. Technical Service Engineers are ready to help you select the best resin and operating conditions for your application. Just give us a call.

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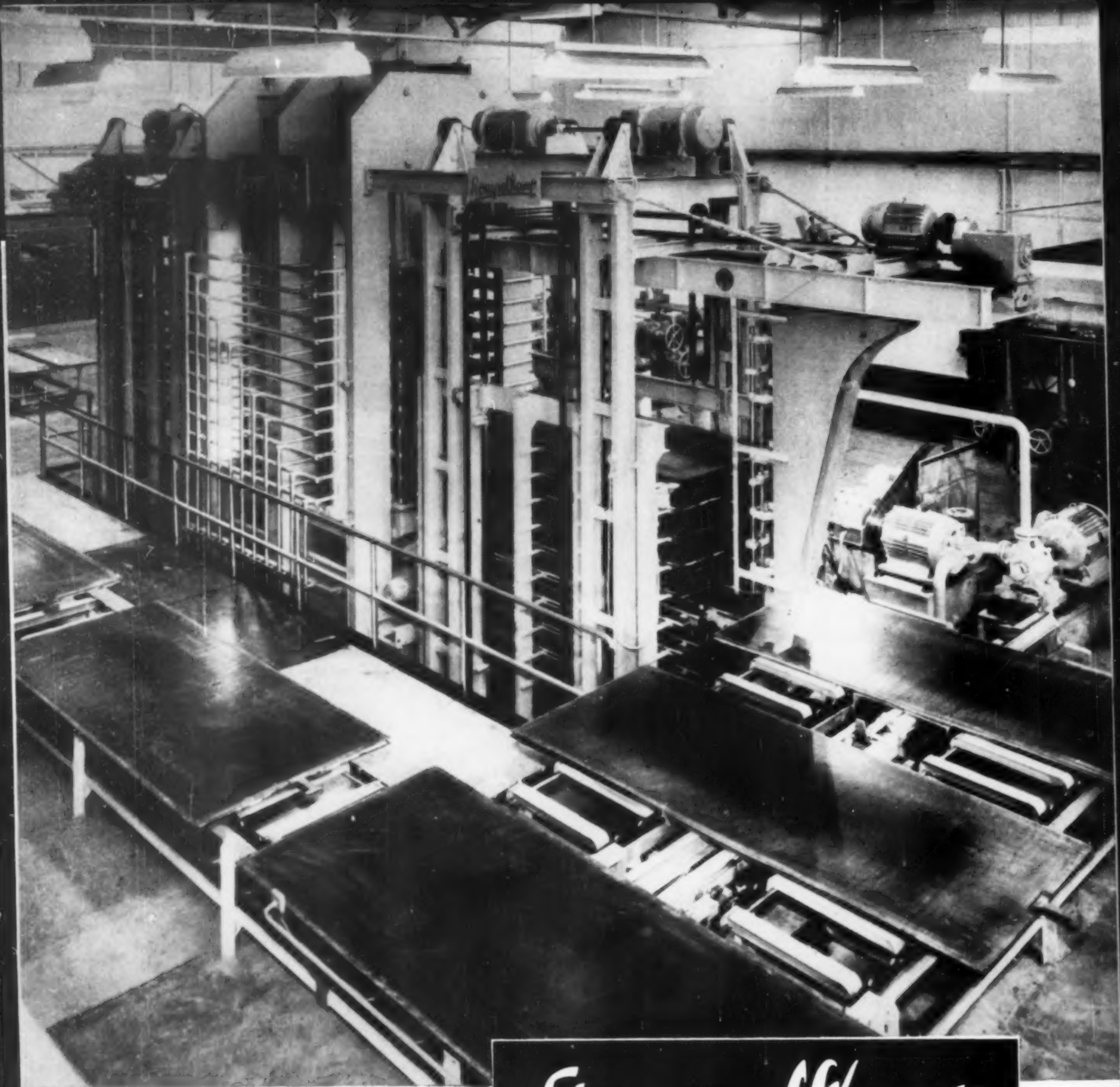

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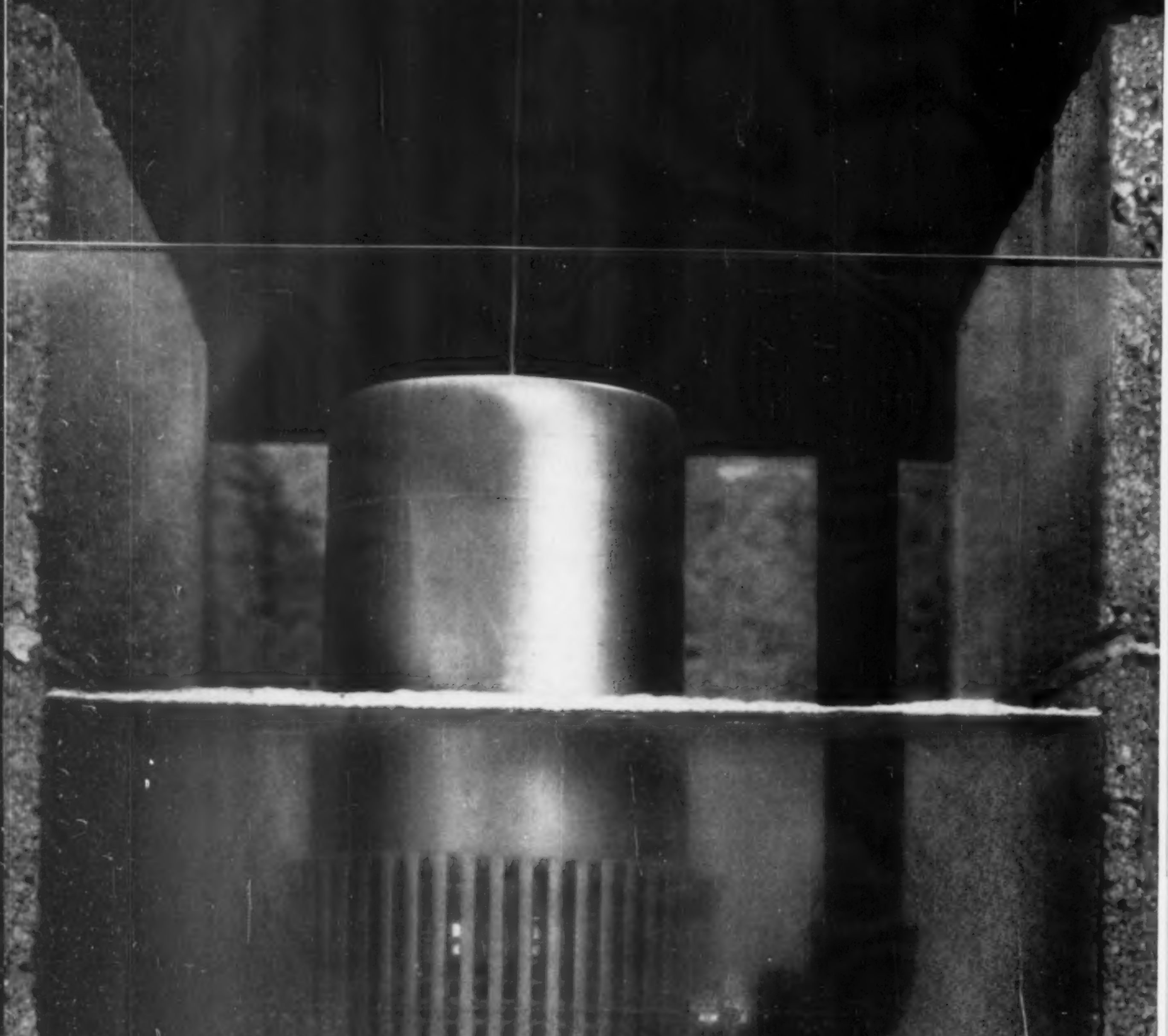


...another way high-density polyethylene IMPROVES YOUR PRODUCT

TYPICAL PROPERTIES OF DMD-6001

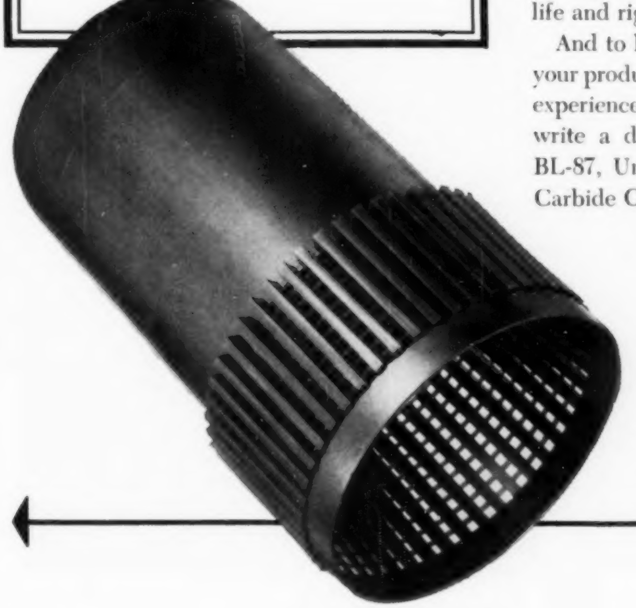
Properties	ASTM Test	Typical Value
Density, gm/cc	D 1505	0.950
Melt Index, gm/10 min.	D 1238	2.0
Tensile Strength, psi	D 638	3,400
Elongation, %	D 638	45
Secant Modulus (Stiffness), psi	D 638	100,000
Hardness, Durometer "D"	D 676	60

DRAINAGE WATER CONTAINING harsh detergents and common corrosives can be a problem for sump pumps, but Fostoria Corporation's new submersible "Dynasump" is highly resistant to household chemicals. An integral component of this non-corrosive construction is the combination cover-strainer molded of BAKELITE high-density polyethylene DMD-6001.

Tough and rigid, this high-density polyethylene also contributed to Fostoria's new design concept. These properties, along with the excellent molding characteristics of DMD-6001, made this complex, one-piece molding possible; details are clean and sharp. The result is a durable, functional, good-looking part that meets every requirement at low cost.

Finding the right combination of polyethylene properties is made easier by the variety of BAKELITE Brand polyethylene formulations available today. In addition to the low, medium, and high densities, the list also includes the remarkable new polyethylene copolymers. Such properties as stress-cracking resistance, moldability, dimensional stability, toughness, flex life and rigidity can be specified in the degree you require.

And to help in applying the properties of these materials to your product, you can call on the same technical knowledge and experience that developed them. Mail the coupon today, or write a description of your requirements directly to Dept. BL-87, Union Carbide Plastics Company, Division of Union Carbide Corporation.



Fostoria "Dynasumps", designed for rigorous underwater service, are housed in covers molded of BAKELITE Brand high-density polyethylene DMD-6001. The cover-strainers are molded by Haas Corporation, Mendon, Michigan.

"Bakelite" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

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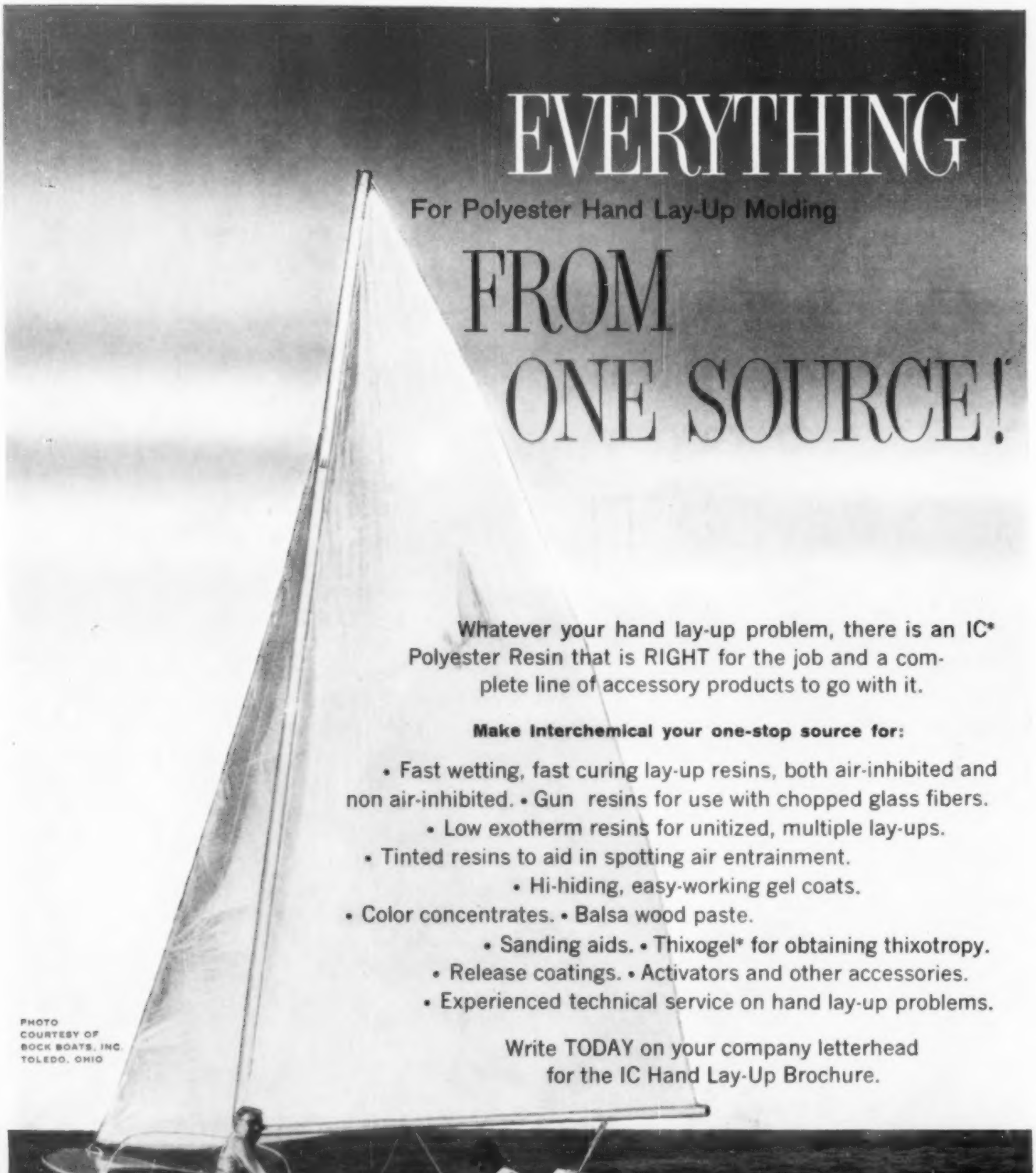
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1 Color Control Substitute BC-200 or BC-206 for present liquid Barium-Cadmium or Barium-Cadmium-Zinc stabilizer. Work continuously on 2-roll mill at suitable fluxing temperatures, removing samples at fixed intervals. Compare color maintenance to present stabilizer.

2 Over-all Heat Stability With identical formulations, except for the stabilizer, use oven or continuous mill test. Compare BC-200 or BC-206 with stabilizer currently being used.

3 Clarity Press-mold a thick milled section or laminate milled films to a thickness in excess of 0.100. Compare BC-200 or BC-206 with present Barium-Cadmium or Barium-Cadmium-Zinc system, for crystal clarity.

4 Extended Aging or Storage Stability Prepare milled films containing BC-200 or BC-206, as well as films containing presently used stabilizers. Expose 10 cc. of each stabilizer to uniform air surface area. Allow to age for any desired time interval at room temperature or slightly elevated temperature and/or humidity. Compare aged stabilizers in milled films to the films containing the fresh stabilizers. Oven test all films simultaneously. Note degree of performance loss for each stabilizer.

5 Formulation Versatility Compare BC-200 or BC-206 to present Barium-Cadmium or Barium-Cadmium-Zinc stabilizer, in formulation with and without phosphate plasticizer. Compare stabilizer versatility with lubricants other than stearic acid. Use oven or mill test.

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This connector routes many circuits in the Bell System's multi-line "Call Director" at a great saving of space and weight.

About the size of a cigarette lighter, an Amphenol-Borg Electronic Corporation connector is used in the Bell System's "Call Director." This versatile telephone can handle as many as 29 outside lines or extensions. The working members of this connector are fifty gold plated bronze contacts held firmly in a body molded from DAPON (diallyl phthalate) Resin.

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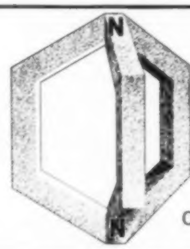

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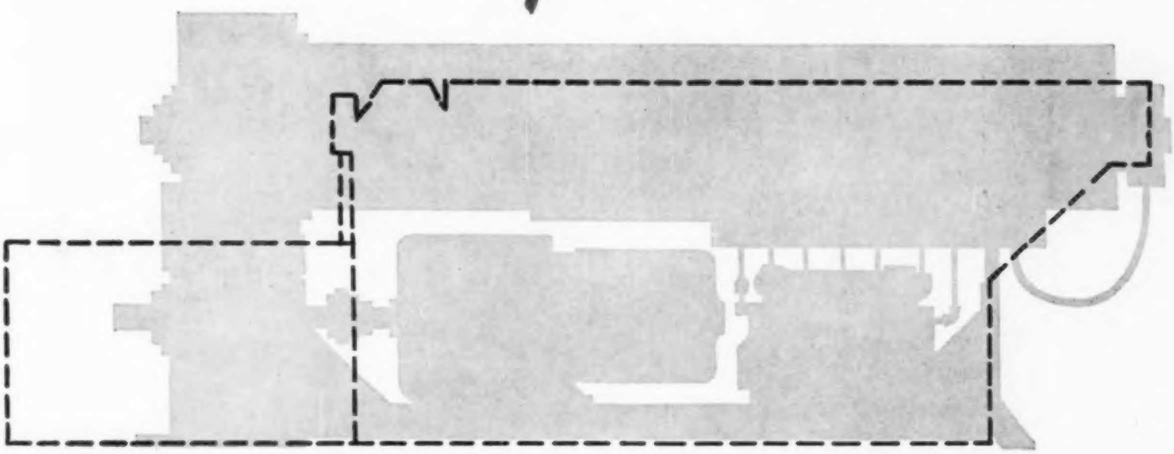

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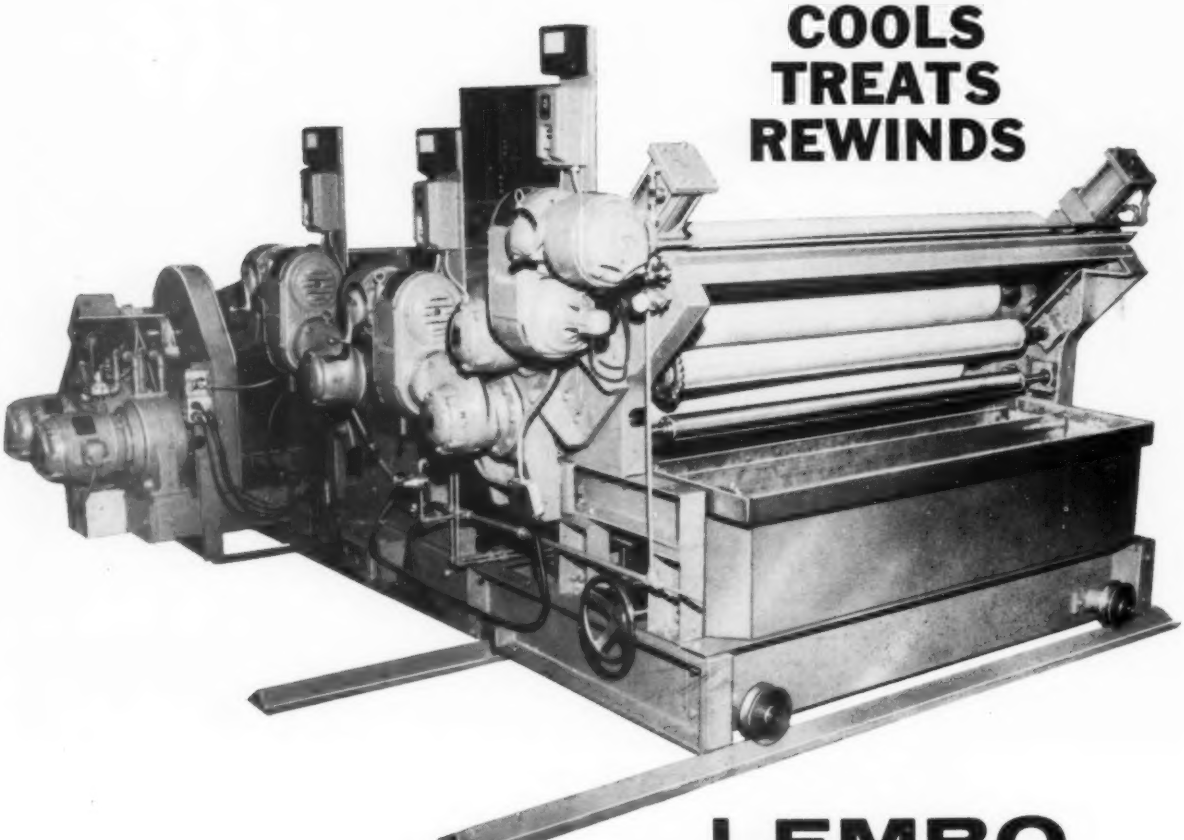

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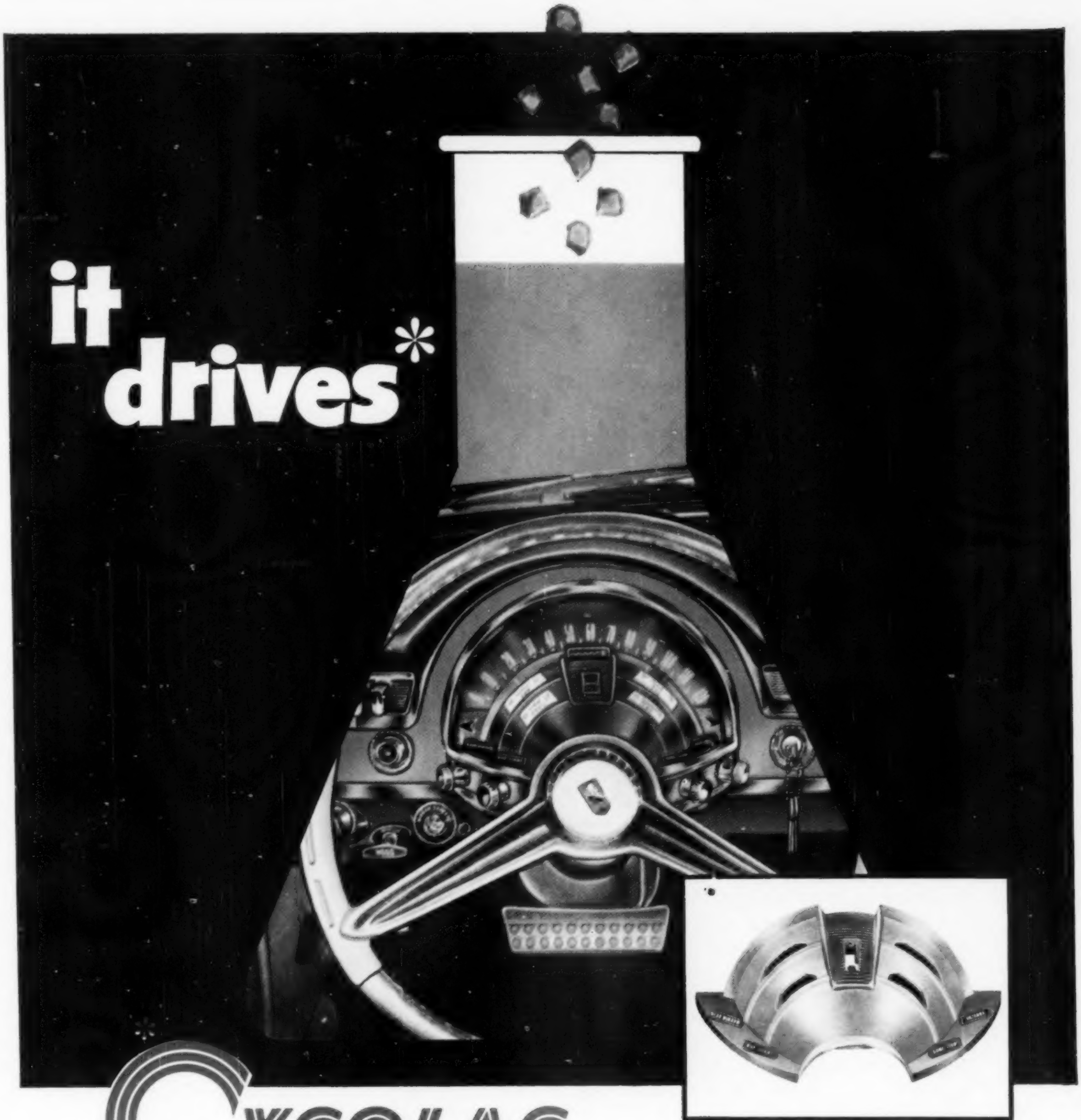

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Every year, the auto industry finds new applications for CYCOLAC—to the tune of important savings and an improved appearance for many products. The 1960 Chrysler instrument panel you see above is a typical example.

This unique panel, molded of Borg-Warner CYCOLAC, cuts production costs because it replaces expensive die-cast metal with economical molded plastic. It also replaces chrome plating with vacuum plating . . . another cost-economy. Product-appearance is improved because the toughness, hardness and rigidity of CYCOLAC enable it to keep its "like new" look for many years.

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Grueling use-test pits monomeric vs. polymeric plasticizers

Some years ago a vinyl upholstery manufacturer decided to field-test new materials for truck and transportation upholstery using a wide variety of monomeric and polymeric plasticizers, including Plastolein 9720. To compare *permanence* and *durability,* the different materials were installed on city bus drivers' seats.
Here, seat upholstering would certainly be exposed to extraordinary abuse almost around the clock . . . continuous rubbing and flexing, city grime and grit, oil and grease.

After a certain period of time, all the upholstery containing monomeric plasticizers had failed. But all those made with polymerics, including Plastolein 9720, were still in excellent shape. With this evidence, the manufacturer concluded that only a polymeric plasticizer would meet its standards for truck and transportation upholstering, and protect its reputation. And Plastolein 9720 was chosen on the basis that it was the *lowest cost of all the fine polymerics tested.*

Today, Plastolein 9720 is *still* the lowest cost ploymeric plasticizer, and is *still* being used by this and many other manufacturers in such heavy-duty goods.
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June 1960, Volume 37, Number 10

MODERN PLASTICS

Boom ahead for styrene foam

Major breakthroughs are expected in expandable styrene beads. Here's what you must know about materials, processes, markets, and economics to engage in this growing industry

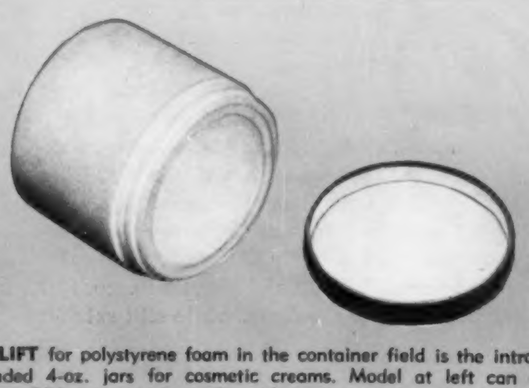
It now looks as if expandable polystyrene foam may turn out to be the next big breakthrough in plastics.

From a few pioneers in 1955, this segment of the industry has grown to over 100 custom molders to date. Within the next few years, that number is expected to double; and, what's even more important, captive operations established by large-volume users are almost sure to contribute further—and heavily—to the rapid expansion movement.

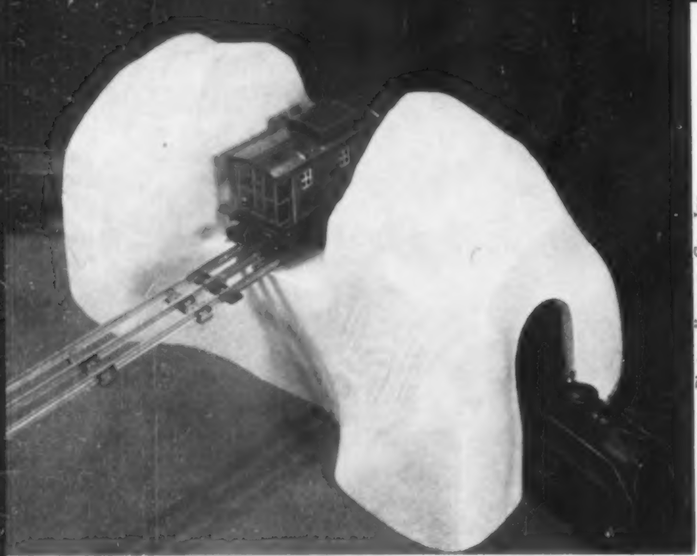
The markets? Packaging, displays, flotation, appliances, insulation, toys, building construction, and furniture—to mention only some of the existing volume applications.

Success for any molder will depend on efficient processing, economical mold design, reli-

Photos, Sheffield Plastics Inc.



BIG LIFT for polystyrene foam in the container field is the introduction of threaded 4-oz. jars for cosmetic creams. Model at left can effortlessly support 280 jars, which stack easily and weigh less than ½ oz. each—one-tenth as much as opal glass. The smooth polished containers (see close-up above) also cost 20% less and are virtually unbreakable.

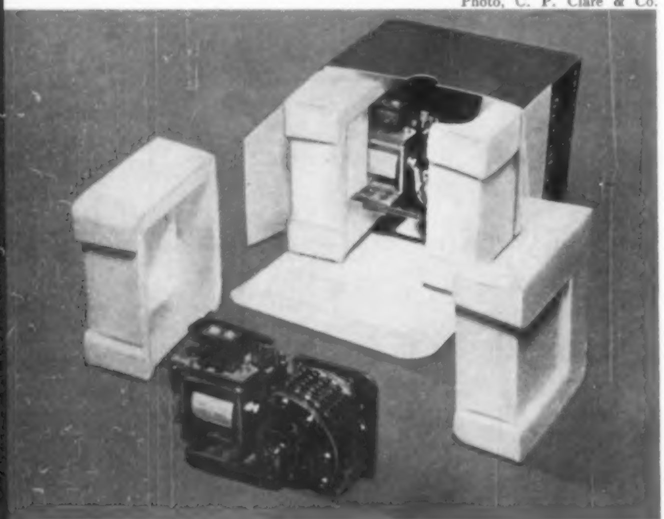


TUNNEL for use in hobby railroad layout molded by Life-Like Products shows potential of foam in the toy field. The material can also be colored and complete scenic panoramas can be molded.

Photo, Koppers Co. Inc.

COMPLEX CONTOURS of fragile items are securely cradled in molded package for A. C. Gilbert Co. microscope sets. Clean foam also adds to the sales appeal.

Photo, C. P. Clare & Co.



MOLDED END CAPS protect delicate telephone relays during shipment better than cardboard, while reducing cubage and weight.

able service, and selecting the right market. Without these, he might find it difficult to survive in a business climate that's going to be highly competitive.

What are the materials?

Expandable polystyrene is produced as free-flowing beads containing a hydrocarbon propellant which causes them to expand when subjected to heat. This process changes bulk density from approximately 38 lb./cu. ft. to the lowest commercial density of about 1 lb./cu. ft. At this last density the foam, while still retaining body, is lighter than cleansing tissue. The beads are supplied in various sizes, in regular and self-extinguishing grades, by Koppers Co., Pittsburgh, Pa. (Dylite); The Dow Chemical Co., Midland, Mich. (Pelaspan); and United Cork Companies, Kearny, N. J. (Uni-Crest).

Foaming consists mainly of two steps: 1) pre-expansion of the virgin beads; and 2) further expansion of the pre-expanded beads within the shaping confines of a mold. Beads can be charged directly into the mold and expanded. But pre-expansion is necessary where uniform or low densities (3 lb./cu. ft. and below) in the finished article are desired. Pre-expansion can be accomplished by steam, radiant or oven heat, or hot water.

Foams from expandable polystyrene have a closed-cell structure, controllable density, low thermal conductivity (a K factor of around 0.24 at the average commercial density at 75° F.), low water absorption, low water vapor permeability, tensile strength of around 30 p.s.i., and compressive strength of 14 p.s.i. at the 1 lb./cu. ft. density. They resist acids and alkalies and do not embrittle at sub-zero temperatures. The foam is essentially rigid, although several companies, including Plastifoam Corp., Rockville, Conn.; Gilman Brothers Co., Gilman, Conn.; General Foam Plastics Corp., Portsmouth, Va.; and more recently, Armstrong Cork Co., Lancaster, Pa., have produced flexi-

ble varieties. The natural color of expanded beads is white, but they can be dry colored or solution dyed before pre-expansion, resulting in pastel colored molded articles. Deeper colors have not yet been produced successfully on a commercial scale.

The truck load price of beads is 37¢/lb. for the standard grade, and 45¢/lb. for the self-extinguishing grades.

How beads are pre-expanded

One of the most successful methods of pre-expansion utilizes the Rodman steam pre-expander. This unit was developed by Koppers[1] and is available from The Rainville Co. Inc., Garden City, N. Y., and Artisan Metal Products Co., Waltham, Mass. The machine may be adjusted for producing pre-expanded beads with densities between 1 and 20 lb./cu. ft. One model, with a 200-gal. tank, and operating continuously, can pre-expand 300-lb.-per-hour at the 1-lb. density. A new steam pre-expander, developed by another machine manufacturer, reportedly results in equal expansion of each bead and is said to permit a density control of one ounce by volume.

Radiant (infra-red) heat expansion utilizes an endless conveyor belt which passes a layer of raw beads under a bank of electric heating elements. The slower the belt speed, the lower the density of the product. Limitations of this process are low production rates; a minimum pre-expanded bulk density of 2 lb./cu. ft.; and some fire hazard. Radiant heat pre-expanders are manufactured by F. F. Slocomb Corp., Wilmington, Del., and sold by Rainville.

Hot water and oven pre-expansion are mainly suitable for laboratory applications. In the first, beads are submerged in boiling water and kept slurried by a stirring device; in oven pre-expansion beads are sprinkled on a tray which is then placed in an oven at approximately 275° F.

Prior to molding the pre-expanded beads are generally "aged" or stored to permit stabilization of air pressure within the bead cells. The length of storing time varies inversely with the density and amounts to between 4 and 48 hr. for a 1 lb./cu. ft. density. At least one machine manufacturer hopes to eliminate this step in the production cycle.

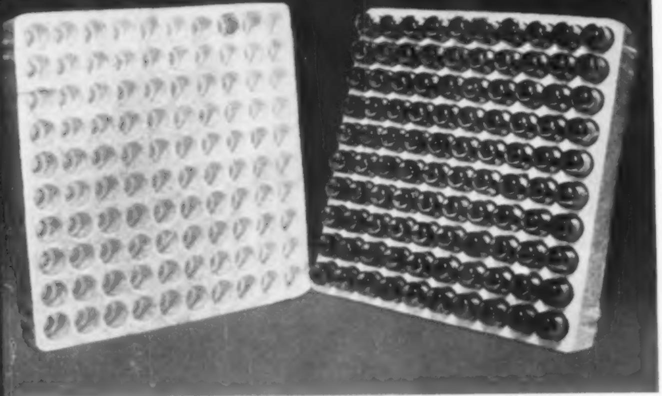
About molds and molding

Very large molds, such as those for planks, can be filled by gravity. Single or multicavity molds can be sweep-fed in some instances. But in most operations, blow filling—conveying the material into a mold cavity by the use of com-

[1] U.S. Pat. applied for.

Photo, Electro-Voice Inc.

HI-FI LOUDSPEAKER CONES, 30 in. in diameter, are fastened on production line. Paper cones lack the rigidity of polystyrene foam, and other rigid materials are too heavy.



COMBINATIONS of matching trays in two basic heights are used interchangeably by RCA to ship miniature receiving tubes with overall lengths from 1¾ to $3^{1}/_{16}$ inch. Sullifoam Inc. molded the 10½ in. square trays which hold 100 tubes.

KEEPING MILK HOT for hours and protecting glass against breakage is easy with lightweight container molded by L. M. Plastics Co.

COLD WATER LINES at Idlewild Airport, New York, N. Y., are insulated with foam covering molded by Mundet Cork Corp. While one workman applies asphalt emulsion to inside cover for tighter fit, other workman (at rear) ties steel band to hold foam.

Photo, Koppers Co. Inc.

pressed air—is preferred. It results in more uniform part density; faster filling; elimination of "flash" since the mold is filled in the closed position; reduces waste; and permits greater flexibility in part and mold design. Adjustable blow guns, designed specifically for filling operations, are supplied by Goulding Mfg. Co., Saginaw, Mich., and Rainville.

The most common form of mold is a cast aluminum die surrounded by a steam chest. The steam heats the mold and furnishes steam to the mold cavity through small holes or core box vents. Cooling water is circulated or sprayed to provide maximum cooling of the mold and the molded part. Molds can be made by any competent foundry, but the mold design requires an understanding of the special problems of working with expandable polystyrene, especially even steam distribution.

Mold costs vary considerably. Springfield Cast Products Inc., Springfield, Mass., a company that has much experience in mold construction for expandable polystyrene, has made sample molds from \$150 to \$900 each, and production molds costing from \$1000 to \$11,000. The cost of the average production mold is in the range of \$1500 to \$3500. These molds incorporate automatic or hand feed; Teflon coated cavities; spray cooling on the outside of the cavities; provisions for steam and drains. They can be produced with practically any number of cavities.

What's the machinery picture?

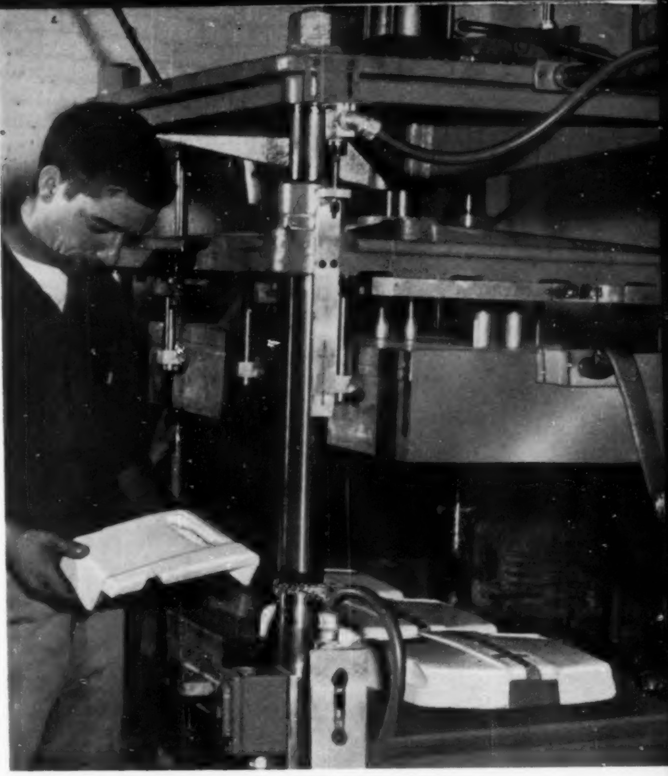
Many producers have adapted all types of presses for molding beads, since no compression is required and platen presses operated by air or hydraulic cylinders, or self-clamping molds are frequently sufficient to resist the pressures exerted by the steam and the expanding polystyrene. However, several companies are making efforts to develop more efficient machinery and to provide varying degrees of automation. The growing interest in expandable polystyrene has created so much activity on the part of machinery manufacturers, that obsolescence of equipment is an important consideration in estimating production costs. Many people in the industry feel that equipment should be depreciated over a period of four years or less. Only an extremely versatile machine is likely to give efficient service beyond that period.

A typical vertical hydraulic press manufactured by Springfield Cast Products Inc., with a 28-ton capacity, a 42- by 42-in. opening between guide posts, and a maximum press open-

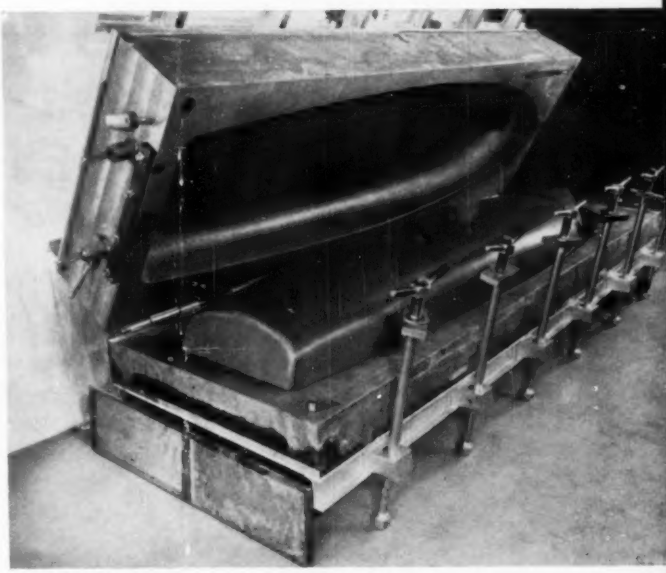
ing of 46 in. with a 40-in. stroke costs $6000. It automatically controls closing, loading, steaming, cooling, and draining. The company is now constructing a horizontal press which incorporates automatic feeding and ejection. The cost for this machine has not yet been established. Tronomatic Machine Mfg. Corp., New York, N. Y., supplies a range of presses from 40 to 100 tons, designed for a minimum internal molding pressure of 35 p.s.i. The fully automatic machines are actuated by compressed air. One special feature is 40 in. of daylight on a 16-in. stroke. Completely automatic units ranging from 24- by 36-in. platen area, up to 49 by 73 in., cost from $9000 to $12,000. The press itself, without the automation features, costs about $6000.

Complete automation from pre-expanding the beads to ejecting the finished molded parts at a rate approximating injection molding cycles has not yet been achieved, but should be expected soon. Without it, markets that are already "sold" on the material but not on the processing—primarily the packaging and container field—may not be fully realized. Along these lines, one company is building a machine which is designed for volume production. A prototype has been in operation for more than a year and a further refined version should be on the market within a short time. This machine does not have platens, but "grids" 48 in. high and 60 in. wide, on which the molds are mounted. Widths of molds can be designed in 3-in. increments and vertical dimensions in 1-in. increments. It employs a dual steam pressure system—60 p.s.i.—for quick preheating of the molds, resulting in a better surface gloss of the finished product; and 20 to 35 p.s.i. for fusing the beads. According to the company, storage of pre-expanded beads is eliminated; loading of molds is automatic; condensation is virtually eliminated; removal of parts is simplified; and all stages of the operating cycle are reportedly speeded up. Another advantage claimed for this machine is that different products can be run simultaneously since all molds have the same height between mounting surfaces in the closed position, and each mold is loaded separately. This would permit, for example, the simultaneous molding of five different-size flower pots in different colors at a rate of about 40 pots a minute. The complete unit costs about $36,000.

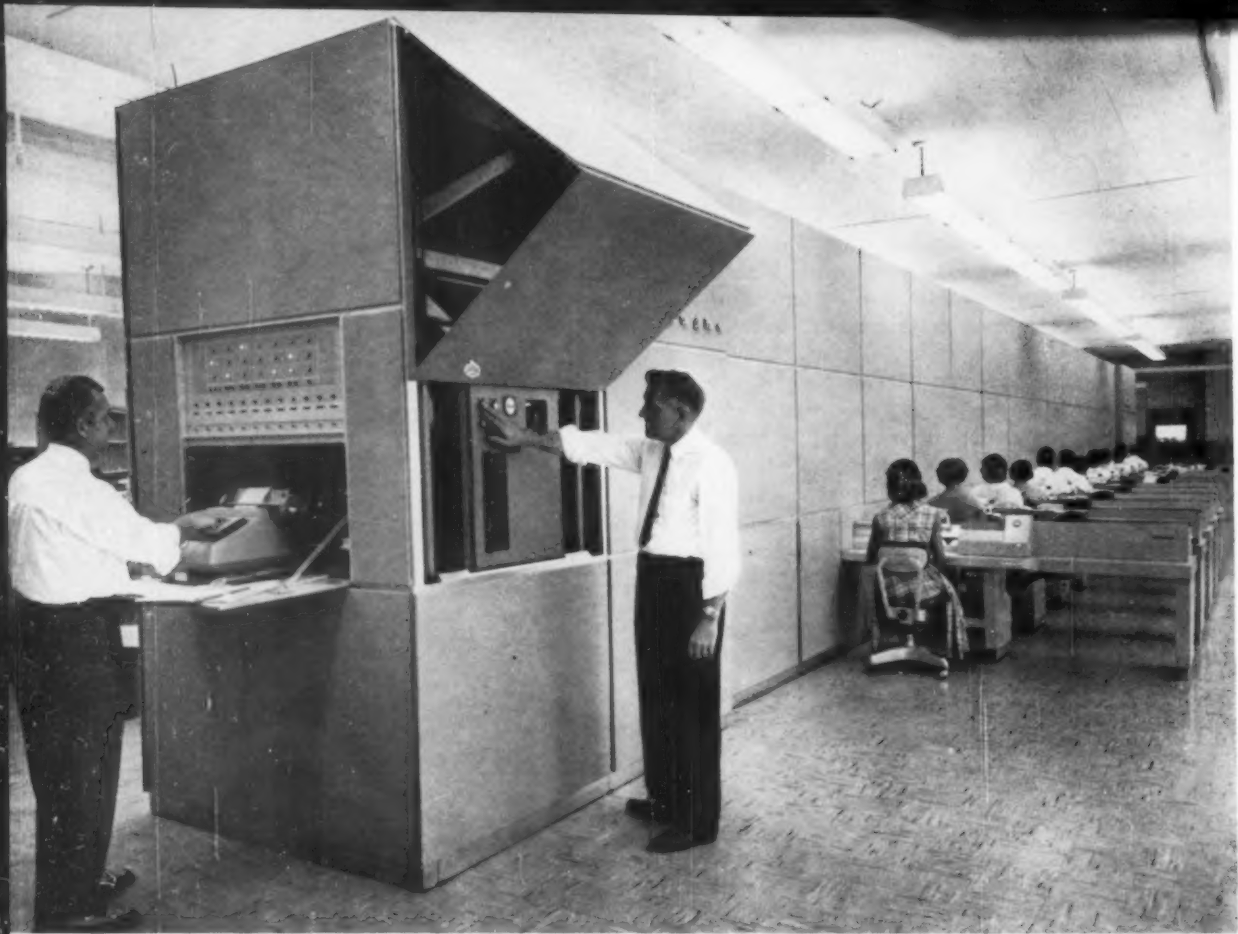
The introduction of high-speed equipment naturally involves a larger initial capital outlay and requires volume customers. **(To page 186)**



SIX-CAVITY pressure cast aluminum mold mounted on 12.5-ton Springfield Cycle-Matic press in open position. Mold is filled automatically by venturi (center right). Machine is making end packs for Royal McBee portable typewriter on a 1.75-min. molding cycle.



SELF-CONTAINED pressure cast aluminum mold for Sea Snark boat, which measures 11 ft. long, 3 ft. wide, and 12 in. deep, includes a reinforcing I-beam on both top and bottom. This 5000-lb. mold has provisions for blowing beads into the mold and for steam, drain, and spray cooling in mold chest; venting in the female half for admission of steam into the cavity; and hinge and locking device, as well as a permanent parting agent that is bonded to the cavity surfaces of the mold.



ENTIRE EXTERIOR of mail sorter is enclosed by plywood sandwich panels surfaced with vinyl-clad steel. Supervisor (right) regulates speed of machine.

POST OFFICE MODERNIZES—

DESTINATION BINS (279 in all) along back of letter sorter incorporate molded high-impact styrene bottoms. Ribbed construction (close-up at right) facilitates letter removal. Doors are fabricated from ⅛-in. acrylic sheet stock.

Hundreds of pounds of plastics, involving several types of materials, contribute to the manufacturing economy, operating efficiency, and styling of the world's largest-capacity letter sorting machine, recently installed in the Detroit, Mich. Roosevelt Park Annex Post Office. Designed and built by Burroughs Corp. in cooperation with the United States Post Office Department, the sorter incorporates the latest advances in office handling equipment. As such it may be expected to become a repository of ideas for advanced office machine designs, suggesting to other companies ways of updating their equipment through the use of a variety of plastics.

More than doubling the capacity of any existing letter sorting machine, the Burroughs unit measures 78 ft. long, 12 ft. wide (including the operator consoles) and 10 ft. high. With all 12 consoles in operation, the semi-automatic machine is capable of sorting 43,000 letters per hour to 279 destinations. Under present plans, a battery of 30 such machines will be installed in Detroit's new $23 million post office, which is scheduled for completion late this year. Other major post offices throughout the country are expected to follow suit in the near future.

How it works

Major components of the sorter include the operator control stations, or consoles; encoding and decoding units; a recirculating conveyor system, and sorter bins, as well as a supervisor's control station.

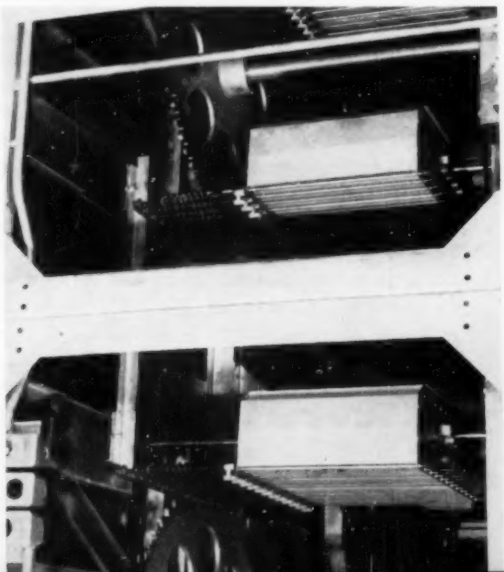
As intermixed letters are moved automatically in front of each operator, he presses several keys, arranging a series of code wheels so that, when the letters pass over a complementing code pattern at the destination bins, they are automatically released from 12-compartment letter carts into the appropriate sorter bin. Code wheels then pass through an ingenious decoding unit, and the process is repeated.

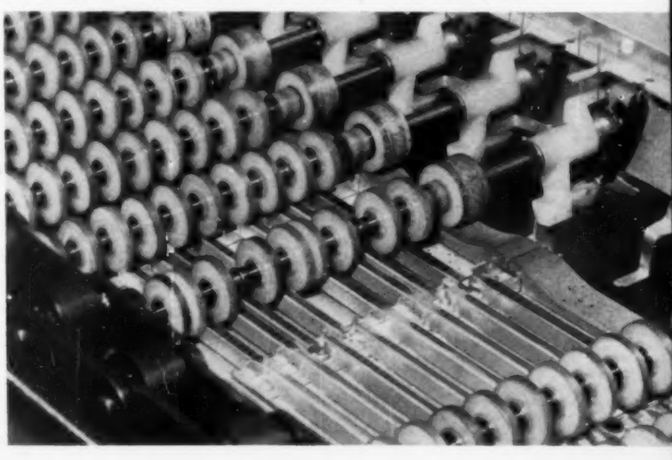
The design of the sorter, according to Burroughs, "involved the use of any material that would result in a top quality product consistent with reasonable manufacturing costs." On this basis, the principal plastics chosen for incorpo-

Semi-automatic letter sorter that brings new efficiency to mail operations relies on vinyl, styrene, acrylic, and nylon for function and appearance

WITH PLASTICS

INTERNAL VIEW (left) of end of the sorter shows the 12-pocket letter carts, which carry the letters to coded destination bins. Also visible are the link chains with nylon rollers, which convey the carts through the machine. Nylon code wheels which cause letters to be sorted into proper bins are shown at right. Machine has 20,000 such wheels.





OPERATOR CONSOLES, which are shown in over-all photo on p. 92. Open view (right) illustrates use of nylon rollers and related parts on belts, which feed letters in toward operator, to be picked up singly by vacuum head. Detroit unit has 12 consoles.

ration in the machine include vinyl chloride sheeting (bonded to steel panels), methacrylate, nylon, impact styrene, cellulose acetate butyrate, and phenolic.

Vinyl-clad housing

The complete exterior housing or "skin" of the sorter consists of vinyl-clad steel laminated to a ⅜-in. plywood backing by Haskelite Mfg. Corp., Grand Rapids, Mich. Haskelite also fabricates the panels to finished dimensions, ready to be mounted to the basic steel structure of the sorter. The vinyl-clad steel material is produced by U. S. Steel Corp. Burroughs engineers estimate that approximately 1100 sq. ft. of it is used in the equipment.

Appearance design of the mail sorter was by Lawrence H. Wilson Associates, Detroit, consultant designers to Burroughs Corp.

As compared to a painted surface, the vinyl exterior skin assures uniform color and texture in the panels. It also eliminates the hazard of "orange peel," which would be present in a painted surface of this area. Scuff resistance and washability of the protective vinyl coating means lifetime ease of maintenance.

Also of interest to Burroughs engineers and the design organization were the saving in weight, as compared to solid metal panels of heavier gage, and the outstanding sound-containing properties of the vinyl-steel-plywood combination, making for reduced operating fatigue and greater personnel efficiency.

Functionally, the outstanding applications of plastics in the mail sorter consist of injection molded and fabricated nylon components. Some 20,000 code wheels, slightly less than 1 in. in diameter, represent approximately 163 pounds of nylon. These parts were fabricated from nylon rod stock in Burroughs' Detroit plant. In addition to the code wheels, support wheels, trip dogs, outrigger wheels, and turn guidance wheels of the letter carts were specified in nylon for good bearing and strength properties and reduced noise. Some of these items are fabricated; others, injection molded. Also of nylon are the rollers used in the chain drive mechanism which transports the 161 letter carts. Diamond Chain Co. supplies this component, which combines nylon rollers and metal links. Nyliner (nylon) bearings are also used in several high volume assemblies.

Including such miscellaneous applications as AMP multiple pin connectors, stop nuts with nylon inserts, and Nylock set screws having inserts of the same material, the total poundage of nylon in the Burroughs letter sorter is estimated in excess of 350 pounds.

Extensive use of Plexiglas cast acrylic sheet stock in the mail sorter **(To page 194)**

MODEL IS HOLDING dinner plate drawer, which shows how design permits accommodation of many shapes and sizes. Note tiered design of indentation of glassware tray that allows various-sized glasses to be readily nested.

"Custom" drawer mass-produced

Formed polystyrene storage units, specifically designed for particular uses, may help break a long standing bottleneck of plastics in furniture

An important new dimension has been added to the plastic furniture drawer market with the introduction by Richardson Bros. Co., Sheboygan, Wis., of contoured polystyrene tray-drawers in several of its buffets.

Until now, plastic drawers were by and large pretty close duplicates of conventional wooden drawers: rectangular boxes open at the top.

The new drawer, on the other hand, by taking advantage of the economies of thermoforming, is produced with contoured indentations to accommodate different kinds of eating utensils. Three models have been produced. One holds plates of any shape and size, the second nests crystal and glasses, and the third stores silverware. Not only do the drawers store these items neatly but also they can be easily taken out of the buffet and carried over to the table to facilitate setting.

It appears likely that an extension of this principle might lead to similarly constructed drawers for linens, shirts, lingerie, and other textile items.

The trays are formed by Robert A. Schless & Co. Inc., Elizabethtown, N. Y., **(To page 196)**

SILVERWARE TRAY holds large selection of utensils. Trays are portable and of pleasing appearance so that they can be brought to table.

Plastics in the product revolution:

MELAMINE DINNERWARE is already a large and firmly established market for the "foil" decorating technique. Patterns shown here illustrate some of the current design treatments—overall patterns, rim decorations, and spots. (Four-color plates, Boonton Molding Co., Boontonware Div.)

A paradox in plastics history is that a molding resin which became commercial as late as 1939 was actually invented 105 years previously. A Swiss scientist named Liebig, in 1834, produced a chemical consisting of carbon, nitrogen, and hydrogen. This was recalled 100 years later by Dr. Palmer W. Griffith of American Cyanamid Co., who was seeking ways to improve urea-formaldehyde resins. Dr. Griffith, studying derivatives of cyanamide, observed an impurity in dicyandiamide which he identified as melamine. Adding this impurity to formaldehyde, and heating the product on a watch-glass, he discovered a thermoset resin.

He found that this resin readily impregnated

DECORATED THERMOSETS

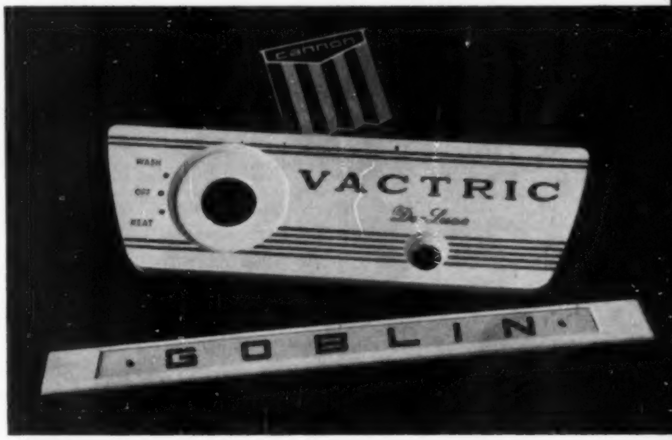
Major breakthroughs in decorative foil extend market from melamine to urea and phenolics, from flat dinnerware to cups, and to deep-draw and compound-curved industrial parts

THE COVER: Foil-decorating technique has progressed from dinnerware (top) to wide range of products (bottom row). Foil shown in center by Commercial Decal, decorated plate (right) by Plastics Mfg. Co., products in bottom row by Ornapress A. G.

cellulosic material, including paper; and, after studying the remarkable heat, light, and abrasion-resistance of such composite materials, Dr. Griffith came to the conclusion that the new resin could supplant thiourea as an overlay material for the new decorative high-pressure laminates then being introduced. Accordingly, he introduced the resin to George Clark, who was then Research Director of the Formica Co., and a revolution in the decorative laminate field was begun.

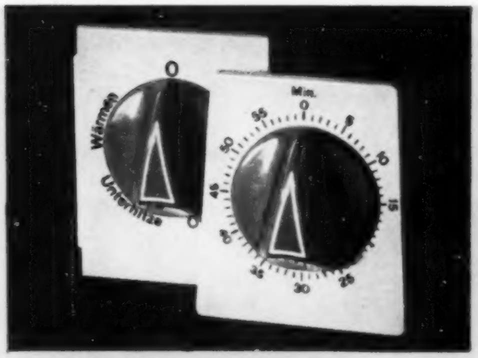
And then, molding compounds

Now, reckoned Dr. Griffith, if this resin could so successfully impregnate cellulosics, perhaps it could be mixed with cellulosic pulp, dried, ground up, and made into a molding powder. This he did in 1938. The molding material was introduced in 1939, in time to be of

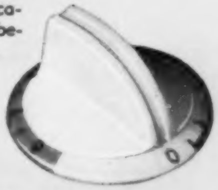


NAMEPLATES and escutcheons represent promising market for decorating technique: lettering and legends are molded in, cannot come off.

Illustrations, Ornapress A. G.

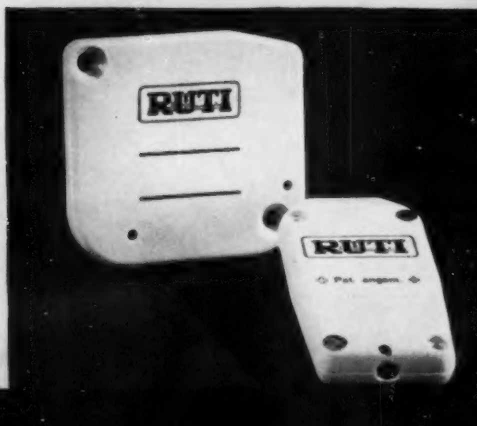


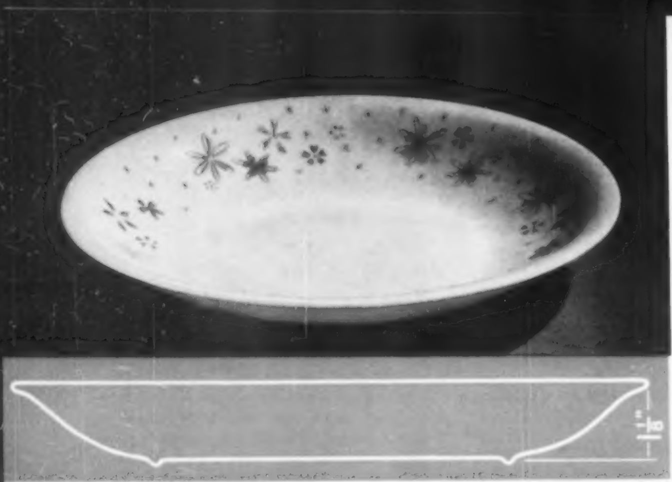
COMBINATION dial plates and knobs (above) take advantage of versatility of decorating medium. Industrial applications such as these are expected to become a major market for this method.



KNOBS are an attractive application for this technique. Since foil can be decorated in many colors, various codes can be molded-in without complicated spray painting procedures.

MELAMINE HOUSINGS (below) for electrical control unit have manufacturer's name molded-in through use of impregnated foil decorating system.





DEPTH OF DRAW possible with decorative foil is illustrated by this soup plate. From rim to inside bottom of plate is approximately 1⅛ inches. Pattern is molded-in without distortion.

great service in electromotive components during World War II. For this achievement Dr. Griffith won the John Wesley Hyatt Award.

Some of the first melamine parts molded were magneto and aircraft ignition parts for Bendix Aviation Corp. A particularly tough job, because it had to be mineral-filled, was an ignition harness component for the Merlin Rolls Royce engine made by Packard Motor Co. for the molded plywood Mosquito bomber, the scourge of Hitler's air force in Norway.

The exceptional dielectric strength of the material, its dimensional stability, its heat and arc resistance, established it as a utilitarian material of great peacetime potential.

Early in the Second World War, the Navy equipped one of its ships with melamine dinnerware. After the war, experiments continued. Later, the Quartermaster Corps became interested in the general use of the dinnerware for the Armed Forces. Thereby began still another revolution.

Commercial dinnerware is next

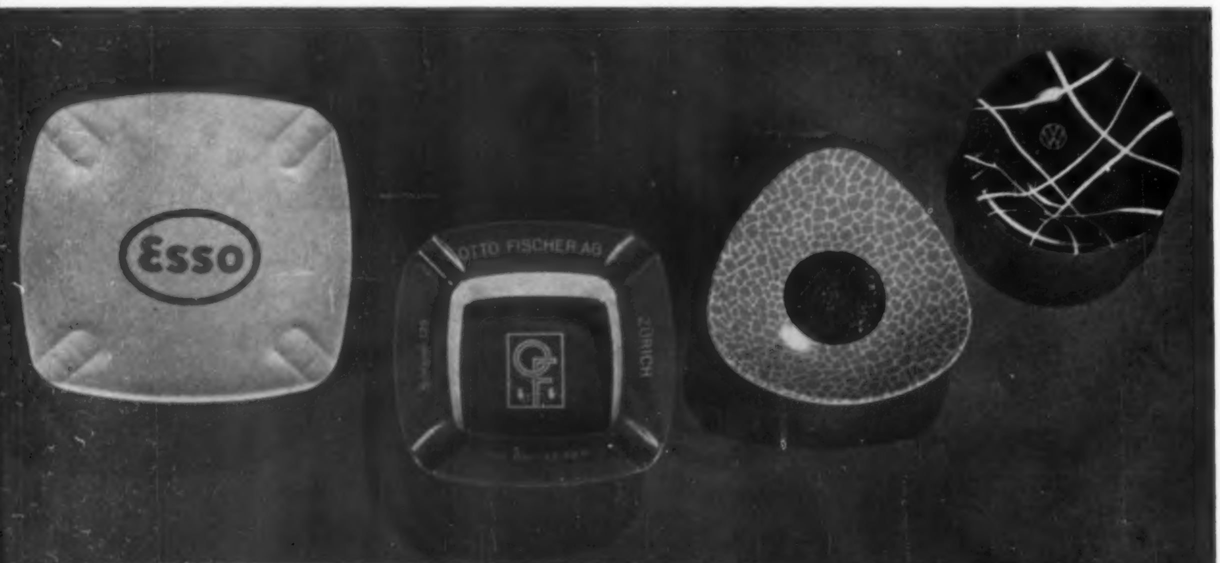
Believing that in tableware, as in electromotive applications, melamine molding material might have a considerable peacetime future, and having by this time learned how to properly color melamine molding powder to the same delicate shades long since available in urea, American Cyanamid Co., in 1945, commissioned famed designer Russell Wright to style a line of dinnerware for hospitals, school cafeterias, and restaurants.

The first moldings were run at American Cyanamid's laboratories, Bound Brook, N. J., and test installations were made in nine locations across the country. There were many problems. Such matters as shape, flash point, finish, and production variables were studied by the laboratory and a team from Newark Die Co., who made original molds. Ease of stacking, shape of vessel, thickness and diameter of product were studied in the field. Market Research Corp. of America was called in to analyze potential consumer markets in both hard and soft water areas where both service and cleaning treatment would be most severe.

Several custom molders then opened proprietary molding divisions to make and market plain colored melamine dinnerware to the mass-feeding outlets, thereby establishing a whole new industry.

The early battles between this newcomer to the tableware market and the entrenched in-

ASH TRAYS run the gamut of design potential—spot, rim and bottom, and overall pattern. Molded of decorated melamine, they provide the institutional user with a highly effective product.



DAISY DESIGN ON PLATE AND SAUCER is repeated on side of cup and coffee decanter. These side decorations are not decals, but are actually molded-in, just as those on the plates.

terests in china and crockery were many and had to be thwarted by expensive, but successful, research programs proving that melamine tableware was safe to use and, indeed, healthier than the materials with which it competes.

Under the auspices of the Melamine Tableware Div. of S.P.I., booklets were prepared for distribution to home economists and managers of mass-feeding establishments. Factual advertisements and articles on the use and care of melamine tableware were placed in consumer and trade publications, first by American Cyanamid and later by some molders. Molders were encouraged to use informative labeling, carrying these same facts. Indeed, American Cyanamid won awards for its informative labels, tags, and brochures.

Merchandising, advertising, publicity, and labeling were not enough. Twelve molders were in the business by 1948, and sales had quadrupled each year since the introduction of the idea in 1945. But there were no standards. Someone could always make a plate thinner, make it faster and give less care to finish in the hope of making a bigger profit. So, again, through the Melamine Tableware Div. of S.P.I., commercial and household standards were developed in cooperation with the U. S. Bureau of Standards, and the end-user was thereby assured of quality.

Family formations in the period 1947 to 1955 were at an all time high, and the new brides took to melamine tableware readily. As more restaurants and cafeterias discovered the economic values and savings inherent to the new ware, the word was spread and sales continued to climb. Department store buyers, faced with the inevitable, learned to display it in competition with their standard dinnerware lines and to use the informative labeling, which was the key to the marketing program. There was still something lacking—another breakthrough was required: decoration.

Discovering the decorating technique

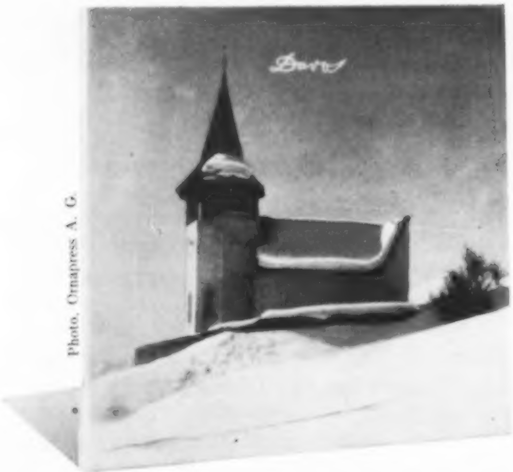
Literally, everything from decalcomania to hand painting was tried. Various textiles and papers were experimented with as overlays. Nothing worked well until 1953, when another Swiss gentleman, Gustav Hessel, came up with several kinds of "foils" printed with compatible melamine inks which would be molded into plates and saucers. First he tried it with printed textiles, but these were expensive and difficult to handle; then came alpha-cellulose papers, and finally an all-rayon paper.

In May 1954, while American Cyanamid's Bound Brook laboratory was working on the development of techniques suitable for mass production of decorated melamine dinnerware by the foil method, the company's Stamford lab came through with a special catalyst which greatly advanced the proposition. At Bound Brook the first rayon paper foils were used.

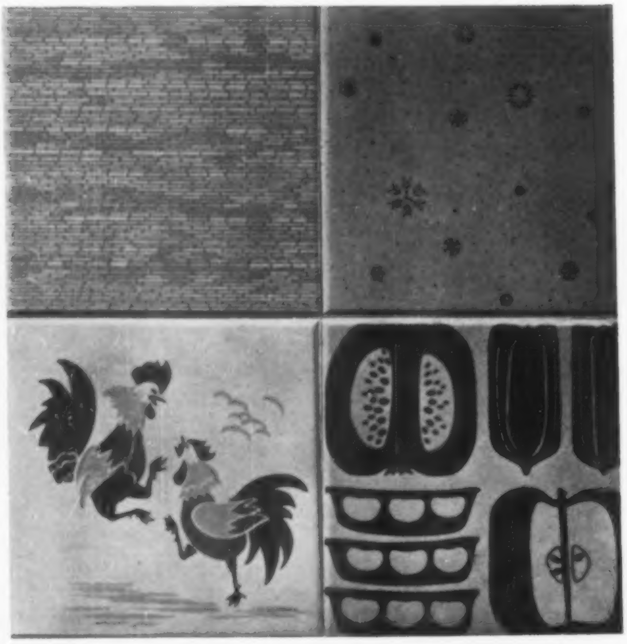
Mr. Hessel was one of the founders of the firm, Ornapress A.G., Zurich, Switzerland,

Photo, Ornapress A. G.

CLOCK AND DIAL FACES, molded of melamine with molded-in decorative foil, can be made in any color combination in one operation, require no decorative after treatment.



Photo, Ornapress A. G.



pioneers of the process, which now has 39 licensees throughout the world.

There was then established a basis of cooperation between Ornapress and Fairhaven Properties Corp. of New York, which introduced the decorating process to the United States and which hold the Fairey Aviation patents, covering a process of handling printed and impregnated foil in the actual molding of tableware and other decorative items in both melamine and urea. Due to this cooperation, several printing organizations were licensed to produce the foils for the molders. This was the breakthrough needed to allow tableware designers to create a product that would compete directly with the finest china.

In the molding process, the foil literally disappeared, leaving the design in multi-color brilliance. Within months after its introduction to the U.S., there were a score of beautiful patterns available, and hotels and restaurants had their crests molded into services.

Back in 1942, Plaskon Div., Libbey-Owens-Ford Glass Co., now the Plastics and Coal Chemicals Div. of Allied Chemical Corp., was licensed to manufacture melamine molding powder, giving the industry two sources of material and adding the emphasis and persuasiveness of more promotional money. The result of all this—business boomed. By 1955 there were 16 molders making melamine dinnerware. In 1960 there are 24. And now, additional molders are coming in, recognizing value of the decorative process for industrial moldings—such as knobs, dials, etc.

Between 1955 and 1960, thanks to the so-called flat "foils," sales of decorated melamine tableware increased to the point where in 1959 70% of the tableware sold was so decorated. But there was still a stymie. Yet another breakthrough was required. The "foils" were moldable only on flat or gently-curved surfaces. Ornapress research and development was directed during this period toward the production of deep-draw "foils" which could be molded into cups, vases, and pitchers. In 1957, Chicago Molded Products Corp., with "foils" produced by Commercial Decal Inc., successfully molded the Schlitztap, a beer tap handle for the Joseph Schlitz Brewing Co., making

FOUR TILES AT LEFT are molded of phenolic with molded-in decorative foil. Tile at top is molded of melamine, decorated with a foil printed with a half tone of a photograph.

Photos, Ornapress A. G.

VERSATILITY OF TECHNIQUE is illustrated by plates above. Stock at left shows half-tone reproduction with sharp cutoff edges. Above are shown a variety of different patterns and sharp draws.

this the first application of the "foil" decorative technique to a compound-curved surface and the first production use of the "foils" outside of the dinnerware field. In the same year, Plastics Mfg. Co., Dallas, Texas, molded tableware with two different colors inside and outside by a process still a secret. In 1958, Kaumagraph Co. developed the first brilliant nonoffsetting gold which compared favorably with a ceramic over-glaze.

And now—the industrial market

Why the emphasis on research into decorative "foils" which would mold into compound-curved shapes? Simply because first, tableware molders and the chinaware people coming into the melamine market wanted to decorate complex shapes and, second, a considerable market was envisioned in three-dimensional decorated molding of knobs, dials, escutcheons, and signs. Beyond all this, research was being conducted on the manufacture of a melamine-surfaced filled phenolic wall tile which would have molded-in multi-color decoration and should compete satisfactorily with the finest hand-made ceramic tile.

In the case of the knobs, dials, and handles for appliances, urea material (5 million lb. annually) has historically been molded and then decorated by hand wipe-on or roll leaf methods. The "foils" could be adapted to urea as well as to melamine if they could be made to take deep-draw. Indeed, some closure molders envisioned phenolic closure bases with decorated melamine surfaces. In the case of the wall tile, there is a known market of over 400 million sq. ft. per year for bathrooms only and, if melamine-sufaced tile would be accepted, it could count on at least 10% of that market or 40 million sq. ft. in a very short time.

The final breakthrough came in March 1960, when Ornapress successfully molded deep-draw ash trays, pitchers, cups, beer mugs, knobs, dials and a host of other products with a new form of drawable "foil." They then went even further. They reproduced, in "foils," full-color photographs which could be molded into souvenir items, and they discovered a low-cost method of reproducing black and white photographs to be molded into enduring plaques.

There is a considerable difference between present American and European methods of producing the rayon paper foils. First, in the U.S., ordinary methods of resin impregnation, such as by roll, are used; in Europe, impregnation is by vacuum process which, it is claimed, puts more of the resin in the structure of the foil, between and around the fibers. Second, in the U.S., printing is done after resin impregnation, which limits the full use of a wide range of color; in Europe the printing is done first and impregnation follows, which is claimed to provide flexibility in the process.

So, over the course of 126 years, the last 26 of them witnessing five technical revolutions, melamine becomes a material of hitherto undreamed of utility and beauty. In 1959, between 55 and 60 million lb. of melamine molding powder were consumed in the United States, and conservative authorities predict sales of 100 million lb. per annum within the next three years. In addition, urea markets are likely to be enhanced by the same factors.

Currently, blue chip processors are moving to take the next logical step: fully automatic molding of "foil"-decorated tableware in all shapes. The development of this equipment will not be inexpensive, but human error will be eliminated and rejects cut practically to zero, thereby building more sales and profits.

Over 300 stores surveyed at the end of 1959 reported that decorated melamine tableware represented 71.8% of their sales and predicted that in 1960 this will rise to more than 75 percent. They also predict a sales increase of 22.2% in 1960 over 1959.—**End**

For precision spray painting:

REAR END of Chevrolet pick-up truck, already painted with one color. Tape has been stripped along sides to produce sharp paint break.

SPRAY PAINT SHIELDS are positioned preparatory to application of second color. Permanent magnets, visible along lower edges of shields, hold masks in place. Molded-in handles facilitate work.

PAINT JOB IS COMPLETE and shields have been removed from truck. Removal of tape completes operation.

STRIPS OF GLASS CLOTH are laid up on "mold" and formed into a laminate, using tooling resin. One advantage of this construction is that damage, should it occur, can be easily repaired.

MOLD FOR SHIELD is actual part on which it will be used, in this case a rear fender. Before laminate is laid up, part is thoroughly cleaned and then waxed for better mold release.

RP shields

Two-tone truck bodies are finished with greater efficiency through use of "magnetized" molded reinforced plastics "stencil." Technique is directly applicable to the mass-production decoration of other compound-curved products

Impressive production economies have been realized by one of the big three automakers through the development of a reinforced epoxy spray paint shield. The new device, in effect a plastic stencil, permits faster work and more extensive and complicated color and paint combination on mass-produced items, in this case truck bodies, than was heretofore possible. While first usage is in the automotive field, the same system can be readily applied in any number of other industries.

Developed by Chevrolet-Janesville, Janesville, Wis., and built with epoxy tooling material compounded by Ren Plastics Inc., Lansing, Mich., the shield replaces the time-consuming paper and masking tape method for blocking out areas for color and design combinations.

In addition to the time savings, the reinforced epoxy paint shields also make possible extensive savings in materials. During 1959, Chevrolet-Janesville, by using the new plastic shields, saved a total of 139,760 ft. of 18-in. wide kraft paper, 18,900 ft. of 30-in. kraft paper, and 244,760 ft. of 1½-in. masking tape.

How it is done

The shield is built as a lamination of resin and glass cloth by hand lay-up. For a mold, the actual part on which it will be applied is used. Thus, the finished shield will follow all contours precisely and fit snugly. Flat, curved, or rounded surfaces present no particular problem, because the shield is designed and built to meet these conditions.

As the shield is being laid up, permanent magnets are inserted at given intervals around the perimeter of the unit and become molded in as additional cloth and resin is laid up. Thus, when the finished shield is positioned on the work, it holds itself in place. And to facilitate efficient usage, handles are also molded in during the lamination process. Cure is achieved at room temperature and takes approximately 24 to 48 hours.

Basic suppliers of the resins used by Ren Plastics in compounding operations for the epoxy materials include Ciba Products Corp., Fair Lawn, N. J., and Union Carbide Plastics Co., New York, N. Y. Safety hardeners used are derived from aliphatic polyamines.

The parting compound technique, used in standard tooling, is also used with the shields to make cleaning easy. Parting agents applied to the shield make it possible to strip off paint build-up quickly and easily.

The step-by-step procedures used in this technique are illustrated in the accompanying photographs.—End

PERMANENT MAGNET is molded into lamination through liberal application of resin, acts to hold shield in position during paint application.

FINISHED SHIELD is lifted off mold. Note molded-in handles. Flash along edges has been removed.

VINYL FABRICS IN A BIG WAY

Pioneer of the mass-produced car applies engineering know-how to establish automated and integrated plant for production of high quality vinyl-coated upholstery fabrics at competitive prices

When one of the big three auto makers establishes a facility geared to produce millions of yards of vinyl-coated automotive trim material annually; when this auto maker turns out to be the Ford Motor Co., often called the father of mass-production techniques, then the industry justifiably has a very intense interest in the operation:

How is the plant laid out?

What's the machinery used?

How about quality control?

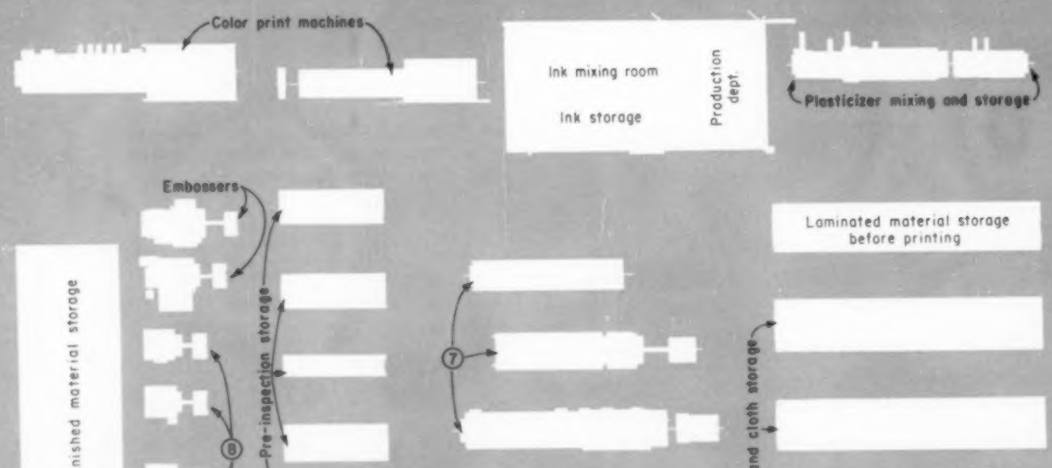
Are there any processing innovations?

How are the fantastic materials handling problems solved?

In order to answer these and other questions, editors of MODERN PLASTICS visited the plant, saw it work, interviewed key personnel, and came up with the following report.

In a $9 million chemical products plant at Mt. Clemens, Mich., a short distance from Detroit, Ford Motor Co. turns out more than 6 million lineal yards of vinyl-coated upholstery decorative trim material annually for the Ford line of passenger cars and trucks. One of the largest installations of its kind, this plant also includes an extrusion department in which the major output is vinyl welting that is used with Ford interior trim.

The Mt. Clemens plant supplies a major portion of Ford's requirements for upholstery trim stocks and vinyl welting. For the 1960 model year, this involves some 250 to 300 combina-

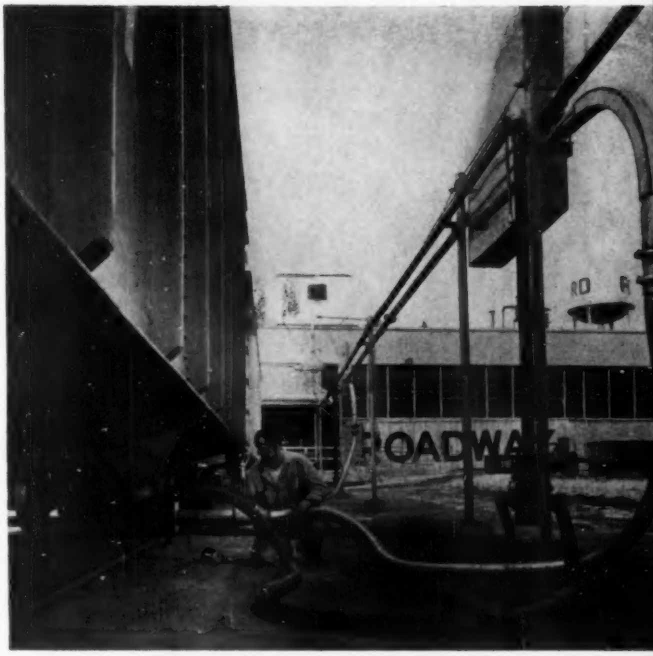


SCHEMATIC DIAGRAM OF FORD'S vinyl fabric laminating plant. Only location of major components are shown. This diagram is not drawn to scale but indicates the general layout of the plant. Process flow is essentially from right to left. Numbers next to equipment link to numbers in captions of accompanying illustrations. Equipment not illustrated in photographs is identified by legend.

tions of color, surface finish, weight, and type of cloth backing. Vinyl-coated fabrics can be produced in widths up to 72 in.; however, the average production width is 54 inches. Individual runs range from a minimum of 200 lineal yards up to 25,000 yards or more. On the average, a period of from 2 to 15 days elapses between receipt of resins, plasticizers, and other raw materials and their conversion into finished coated fabrics.

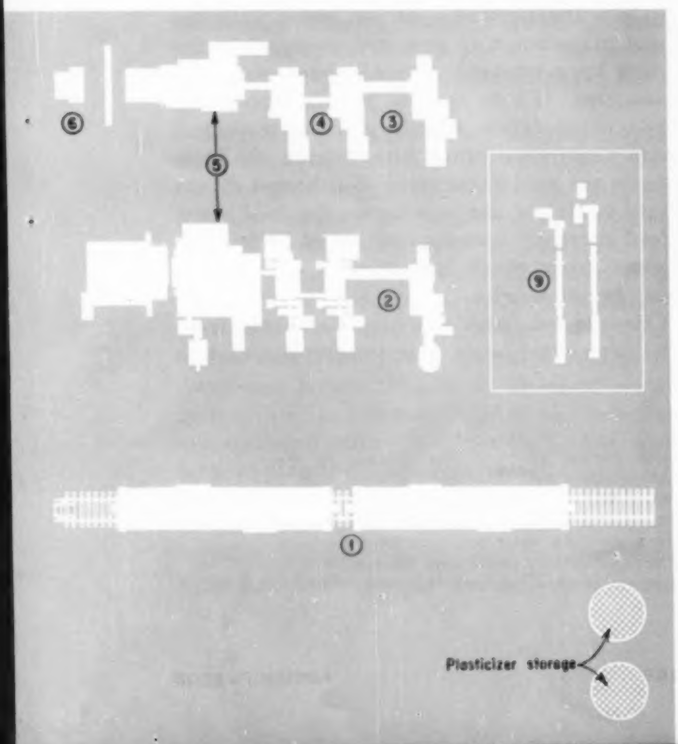
This plant, consisting of about 220,000 sq. ft., includes space for manufacturing, storage, future expansion, research and development, and administrative and service functions. From the standpoint of layout and equipment, it reflects the latest trends in efficient calendering, laminating, and related operations, including bulk delivery of vinyl material in specially designed railroad hopper cars, piping of plasticizers from central storage tanks to the point of use, and the most advanced electronic and Beta-ray equipment for accurate control of the critical calendering operation.

Water used by the plant is supplied by the city system at a pressure of around 40 p.s.i. Full recirculation of water is used on all plant processes. Steam, employed for both heating and processing, is supplied at a line pressure of 185 p.s.i. The plant also utilizes high pressure water (200 p.s.i.) at a temperature of 380° F. Cooling facilities include a 200-ton central unit and about 100 tons additional in individual units;



1—Vinyl resin, delivered to the plant in Airslide cars holding 100,000 lb. of the plastic material, is transferred by vacuum line directly into storage tanks on third floor level at rate of 15,000 lb. per hour. System eliminates handling of individual packages, minimizes likelihood of contamination.

2—Color pastes, formed by mixing dry color pigments and plasticizers, are stored in 55-gal. drums equipped with agitators until ready to be combined with resins and other ingredients. Present production schedules call for approximately 30 basic colors, which are combined to produce variety of mixtures.



3—Banbury operator cleaning loading chute during operating cycle of the Banbury. The vinyl preblender is discharged automatically from the scale hopper immediately behind operator's head. Color paste is added manually to the chute, then the cycle proceeds with the operator performing the blow down operation (shown here) while the Banbury is mixing.

4—After leaving Banbury, the dough-like mixture of vinyl resin and plasticizer, as well as the other ingredients, is worked on a rolling mill until reaching a homogeneous consistency. Passing by conveyor to a second mill, material is worked further to prepare it for the calendering operation. Close control of temperature is maintained by steam heating the rolls.

purchased electricity is brought into the plant sub-station at 4800 volts. Compressed air, supplied at a pressure of 100 p.s.i., is used for process, instrumentation, and cooling purposes. It is supplied by a 200-hp. compressor.

Vinyl resin, purchased from several suppliers, is delivered to the plant in special Airslide cars, each containing 50 tons of resin (Photo 1). Material is transferred automatically from the cars by a TransVair vacuum system into plant storage bins with a 45,000-lb. capacity each. Provision is also made for receiving additional supplies, as required, by truck and rail. The plant uses two basic grades of vinyl—one for calendering and one for top coatings and welting.

DOP and several proprietary type plasticizers, stored within the plant in two 15,000-gal. tanks, are pumped through pipe lines and dispensed directly at the point of use.

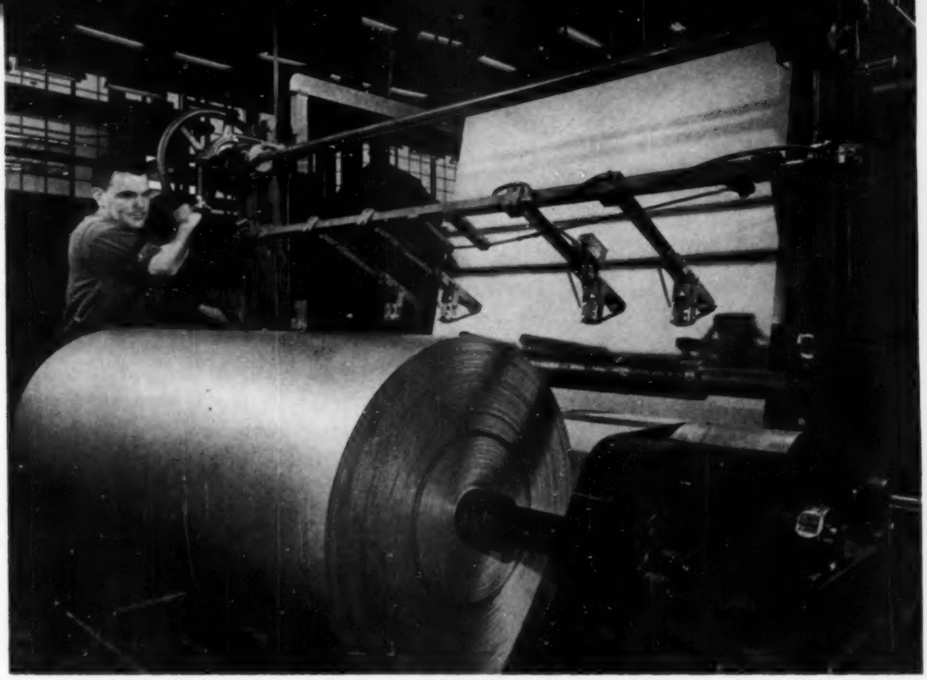
Making vinyl film

Production of vinyl film for the laminating operation begins at the south end of the plant with the dry blending of vinyl resin, plasticizer, filler, stabilizers, and lubricants to produce a dry powder in two Young jacketed ribbon blenders. For this operation, extra ingredients, such as calcium carbonate filler, are added manually. The entire blender rests on a scale so that weight of ingredients can be closely checked as they are added to the mix. After blending, the material drops out on a pneumatic conveyor line and is carried up to intermediate storage in an aftermixer.

Color pastes, which are not added until the next manufacturing step, are prepared in the plant by combining dry color pigments with plasticizer (Photo 2). The paste compounding type of operation affords good color control with minimum dusting. After mixing, the basic pastes are held in standard 55-gal. steel drums until ready for use in coloring the final resin. Ford currently uses approximately 30 primary colors, from which any number of mixtures may be prepared.

Preblended material is next discharged from the aftermixer scale hopper into one of two

5—Most critical part of the process is the calendering operation, in which the vinyl film is reduced to its final thickness. Shown in this photo are the Accuray attachments, which by means of Beta rays scan the sheet and accurately measure the film gage, and by positioning the bottom rolls adjust instantaneously for any variations.



6—Leaving the calender after cooling, the vinyl film is wound on rolls, ready to be laminated to cloth backing. A new roll is started immediately. Sections between color changes are cut out for scrap and possible reprocessing. Finished rolls, with film thickness ranging from 3½ to 24 mils, weigh from 1000 to 1500 pounds.

large Banbury-type mixers located on the ground floor level (Photo 3). The larger of these is a 600-lb. unit; the other has a capacity of 300 to 400 pounds. At this stage, the premixed color paste and supplementary plasticizers are added to the batch. The larger line includes two 32- by 84-in. mills of 200 hp. each (32-in. diameter by 84-in. face); the second line has two 22- by 60-in. mills (Photo 4).

Following the milling operations, material moves to one of two calender lines. The larger calender, a 32 by 84 Adamson United Co. unit, has a capacity of 5000 lb. per hr.; the second calender, a 24 by 60 Farrel-Birmingham, has a 3000-lb.-per-hr. rating.

On the larger calender, an inverted-L-type, three different preblends, six film gages and five film widths are handled. As many as 11 different colors may be run on one shift without shutting down operation of the calender. The calender incorporates four chilled iron rolls, 32 in. in diameter and weighing more than 10 tons each. Their temperature may be individually controlled to a 2° F. accuracy through an American Hydrotherm high pressure water system. Top and bottom rolls of the calender are equipped with "roll bending" units with large hydraulic cylinders which can change roll contour as much as 0.001 in. to control the profile of the sheet.

During calendering, the vinyl film is reduced to its final thickness of from 0.0035 to 0.024 in., depending upon product use. An important factor in accuracy of the finished film is the use of progressive draw control equipment (Clark Control) which provides fingertip monitoring of the plastic material passing through the calender. Through this system, any adjustment made in the speed of operation at the take-off rolls, embosser, cooling drums, or windup are automatically duplicated in correct proportion at the other stations that are set up in the calendering line.

Through the console of this electronic device, the operator can immediately check and if necessary adjust such variables as roll speeds, roll spacing, film tension, and other factors. These calibrations, in turn, are supplemented by an Industrial Nucleonics Accuray attachment housed in the control console. It embodies a Beta-ray attachment (Photo 5) which automatically gages film stock thickness to a differential of ± 0.0002 in., and by positioning the bottom rolls adjusts instantaneously for any variations. Readings, which are made in terms of ounces per yard, are almost directly comparable to film thickness measured in thousandths of an inch.

Leaving the calender, film is automatically trimmed to finished width, rolled on cores and cut off to desired yardage (Photo 6). Finished rolls, weighing from 1000 to 1500 lb. each, are transferred by lift trucks to nearby storage racks preparatory to laminating. The auto-

7—Under heat and pressure, the film is laminated to cloth backing for additional strength and stability. Film also passes beneath embossing roll which gives it desired Morocco grain or other specified surface texture.

8—After going through top coating operation, in which protective film is applied over the vinyl surface, the vinyl-coated fabric is visually inspected for color, grain and appearance and rerolled in smaller rolls ready for shipment to the trim plant. Color matching against master sample under simulated daylight is an important part of this inspection procedure.

9—Extruded vinyl welting used in seaming the coated trim fabric is produced by these two extruders in the Mt. Clemens plant. Welting may be seen emerging from water bath at end of cooling troughs. Immediately upon leaving die head, material passes over engraved roller which gives it a grained surface matching that of the trim stock.

matic cut-off and winding equipment includes an Emco rotary cutter-winder as well as a Dusenbery slitter.

The laminating process

Three laminators—two Lembo units and a third specially built by Ford—are used in laminating the vinyl film to selected cloth backings.

In the laminating operation, the fabric passes through heated rolls for thorough drying, then the backing and vinyl film are fused together under roller pressure at between 320 and 350° F. (Photo 7). The film and fabric pass through an embossing roll which gives the vinyl the desired surface finish and performs the lamination of the film to the cloth at the same time. For the 1960 Ford line, the standard pattern is a Morocco grain effect; other surface treatments are also used to meet specific trim requirements. After the laminating operation, the coated fabric is cooled, rolled, and racked.

Final step in production of the Ford trim stock consists of "top coating." This relatively new development in the coated fabrics field is a printing process in which a highly volatile liquid ink or coating is applied over the vinyl surface and properly dried, sealing the pores of the coating, imparting greater durability, highlighting the color, and giving the stock an improved "sliding" surface. The impervious film also makes the material easier to wash. The top coat consists of approximately 85% solvent and 15% various solids, including color, vinyl resin, and plasticizers. All upholstery trim stock receives this treatment, following which it is dried, cooled and again wound in rolls.

Five printing units are used for applying the top coatings. Since the process **(To page 199)**

Added entry in plastic-clad metal derby

POLYESTER-STEEL COIL LAMINATE

Development of a process for bonding decorative polyester film to continuous coils of strip metal now brings to end product manufacturers a new engineering material which is expected to broaden plastics' penetration into many metal fabrication industries.

Two major television manufacturers (Sylvania and Westinghouse) are already using it for cabinets of some of their models on a production basis. Other commercial products include card tables, chairs, and evaporator-coolers. Home appliances, trailers, institutional furniture, optical equipment, automotive trim appointments, and predecorated wall paneling are additional marketing targets.

Until now, this type of predecorated metal product has been available only in cut sheets, which involve costly handling procedures and material waste. From the standpoint of production volume and costs, the difference between stamping out products from continuous coils of predecorated steel as opposed to fabricating from cut sheets is comparable to the vastly different economics involved in printing a large circulation publication on a modern rotary or a hand printing press.

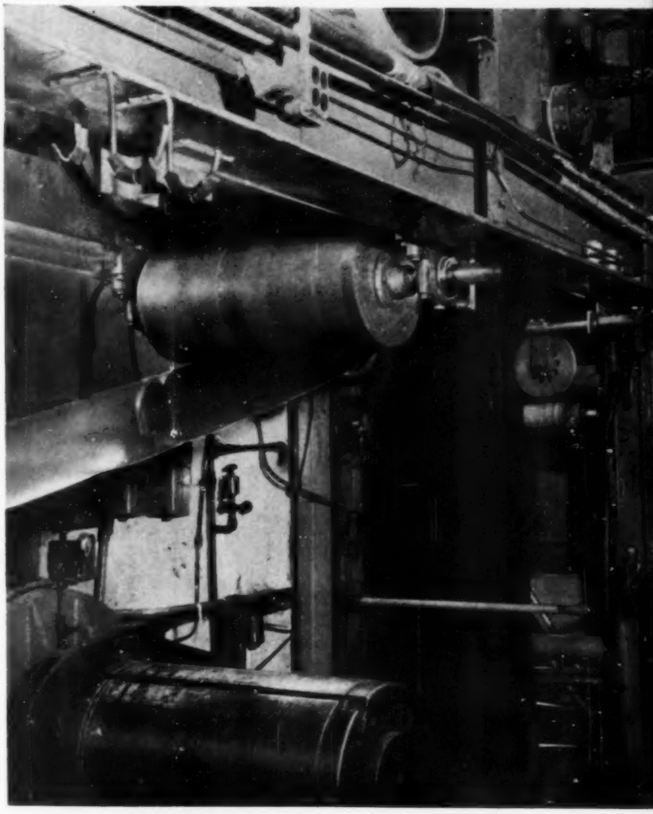
Generally speaking, the cost is about halfway between vinyl-metal laminates and plastisol-coated steel.

What are the advantages

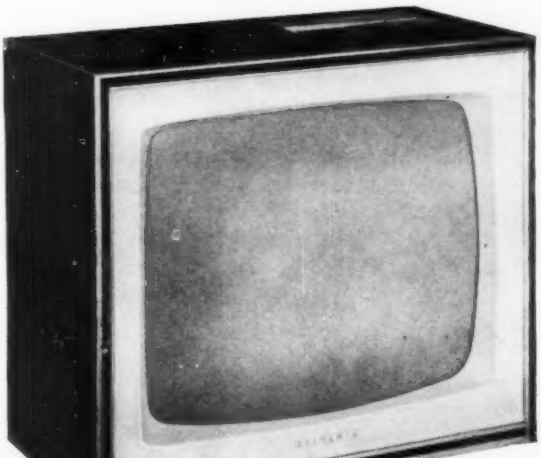
1. Since it comes in coil form, the material need not be hand-fed and requires no change in existing tooling.

2. Although it is predecorated, the material can be fabricated by essentially the same techniques as uncoated steel.

According to National Steel, producer of the plastic-clad metal coil, the decorative surface is protected by the full thickness of a transparent polyester coating. Tests on this coating in 0.3-mil thickness have (To page 204)



END OF PRODUCTION LINE on which polyester film-steel coil lamination is produced. Material with this particular pattern has gone into TV receiver housings on a commercial basis.



FIRST COMMERCIAL APPLICATION of laminate was in television cabinet, where it contributes high styling and long service life. Sylvania's tradename for this finish is Duragrain.

POLYPROPYLENE

Polypropylene has been in the hands of Europeans somewhat longer than it has been in ours. In the case of the Italians the extra time seems to have been well spent in developing and field testing new applications that could be *designed specifically for polypropylene use*. Each of the five applications shown on these pages represents a unique departure from a conventional design that had been originally based either on metal or wood.

With polypropylene booming into prominence in this country in so many different market areas (see "Polypropylene—a product evaluation," MPl, p. 81, March 1960), American manufacturers are studying these new applications. The ideas may come in handy when polypropylene production runs at full capacity.

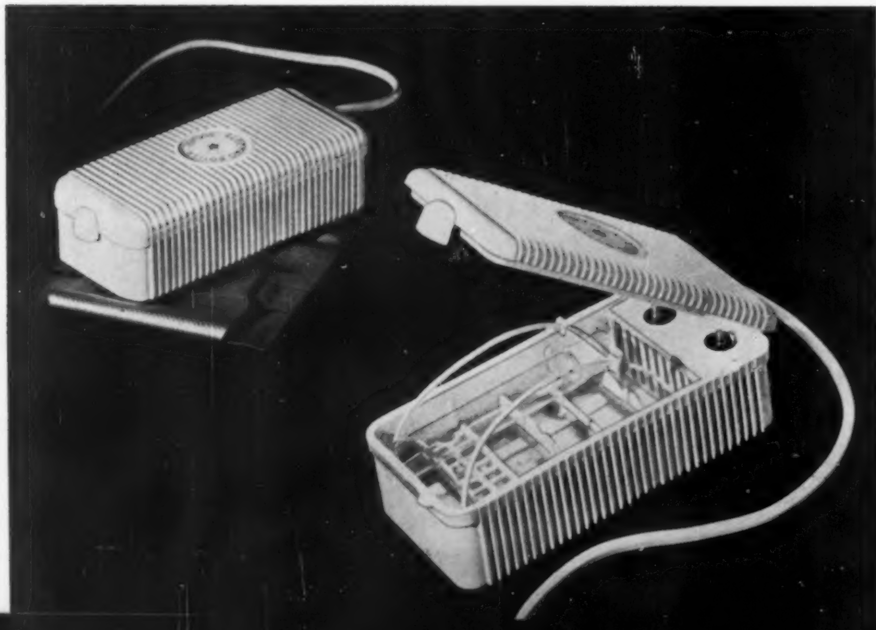
1

Here are five possibilities

1—Electric water heater: Housing for this water heater is made up of two injection molded polypropylene hemispheres joined together by a vinyl gasket snapped over their peripheral rims. Directly below the polypropylene housing is a layer of mineral wool insulation and directly beneath that the spherical steel container that holds the water. Reasons for use: polypropylene offers just the right degrees of rigidity and surface hardness to protect the water heater and its delicate electric components from damage; the material's temperature resistance is just right for the job; and the high

2

3



DEVELOPMENTS IN ITALY

Design potential of material is exploited to the fullest in five outstanding applications reported here

gloss and attractive surface finish of polypropylene add to the unit's visual appeal.

2—Shoe heels: Competing on same level with wooden heels, injection molded polypropylene heels are doing a thriving business in Italy (one manufacturer alone is currently turning out about 2000 a day). Lighter in weight than wood and with better impact strength than wood, the polypropylene heels are produced either as a finished product (with a wood core and aluminum tip) or in a rougher, unfinished version (also with an aluminum tip) that can be turned and shaped on wood working equipment to meet design requirements.

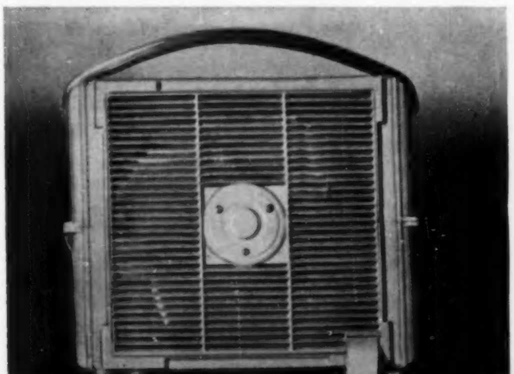
3—Electric sterilizer unit for hypodermic: Molded almost entirely of polypropylene (the only metal parts are the electrical elements and a thin rod which passes through the center of the molded-in hinge that joins cover and case), the new sterilizer unit has already successfully hit the same markets as the more conventional competing models fabricated of stainless steel, aluminum, or enameled steel. Offering sufficient heat resistance for the job (the unit is subjected to boiling water and steam at 212° F.), the polypropylene parts have the added plus of *not* blackening or staining on repeated boiling (one of the limitations with which the metal models are saddled). The good electrical insulating characteristics of PP have contributed to a more compact design of those sections that house the electric components than would have been possible with metal.

4—Condenser housing for air conditioner: In this two-part unit (evaporator and condenser), outside housing of the condenser section is injection molded in two halves of polypropylene and joined together with mechanical fasteners. Aluminum was the main competition for the job but lost out on the basis of polypropylene's lower specific gravity (0.90 to 0.91 as opposed to 2.7 for aluminum) and hence lighter weight (the condenser is a portable window unit) plus the fact that polypropylene offered added resistance to sunlight, was unaffected by temperature fluctuations, fog, moisture, and dirt.

5—Rotary drum for washing machine: Molded in two halves (drum body proper and a flange which runs around the bottom of the unit), the rotary drum is another example of a product designed specifically for polypropylene. Earlier versions of the drum were fabricated of stainless steel or enameled steel plate. The reasons for the switch: polypropylene's resistance to detergents and high temperatures; its lower specific gravity (which resulted in considerable costs savings over the stainless steel model); and its impact strength (which easily outclassed the easy-to-chip enameled steel version). Precision molding made it possible to produce the plastics parts for a perfect fit and the right degree of balance needed for the high rotary speeds to which the drum is subjected. Comparable metal parts would have required extensive finishing operations.

Credit: Polypropylene for these items supplied by Montecatini Soc. Gen., Milan, Italy.

4



5

Monsanto

Adipate Plasticizers

efficiently improve stability

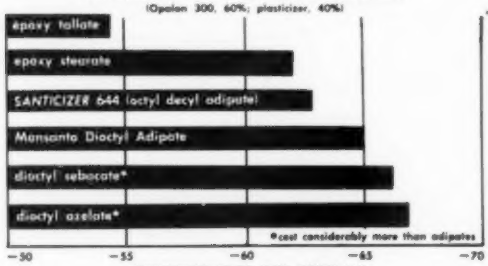
and low-temperature

flexibility of

vinyl compounds

Vinyls plasticized with Monsanto Adipates not only are outstandingly flexible at low temperatures (as low as *minus* 65°C with Adipates at 40 per cent concentration) . . . but they *stay flexible*, since Adipates have low volatility and high moisture resistance.

COMPARATIVE LOW-TEMPERATURE FLEXIBILITIES
(Opalon 300, 60%; plasticizer, 40%)



LOW-TEMPERATURE FLEX POINT, °C

Here are some advantages of Monsanto Adipate plasticizers in specific applications:

EXTRUSIONS. Vinyl tubing, welting, and garden hose have longer useful service life and stay flexible over a broader temperature range through the use of Monsanto Adipates. Very compatible, and with higher solvating power than other flexibilizing plasticizers, Monsanto Adipates increase lubricity . . . are easily processed.

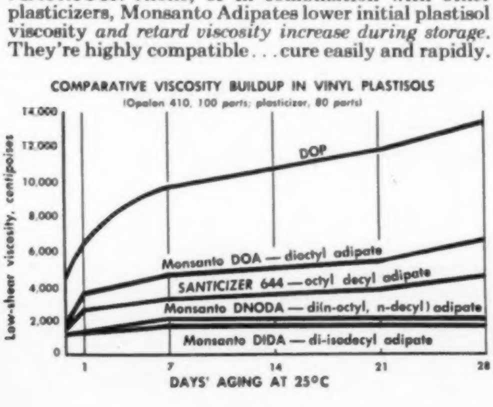
OPALON, SANTICIZER: T.M.'s of Monsanto, Reg. U. S. Pat. Off.

COATED FABRICS. Sheeting and coated fabrics plasticized with Monsanto Adipates have exceptional softness and drape . . . and excellent heat and light stability. And because of low volatility, Monsanto Adipates impart long-lasting flexibility to vinyl auto upholstery and furniture coverings.

INSULATION. Monsanto Adipates assure consistently good electrical properties in vinyl wire coatings and cable sheathing . . . plus increased water-extraction resistance.

PLASTISOLS. Alone, or in combination with other plasticizers, Monsanto Adipates lower initial plastisol viscosity *and retard viscosity increase during storage.* They're highly compatible . . . cure easily and rapidly.

COMPARATIVE VISCOSITY BUILDUP IN VINYL PLASTISOLS
(Opalon 410, 100 parts; plasticizer, 80 parts)



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- *equal the performance of* higher-priced *low-temperature-flexibilizing plasticizers . . .*
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- ☐ Technical Bulletin PL-316 on DNODA
- ☐ Technical Bulletin PL-644 on ODA (SANTICIZER 644)
- ☐ Samples of Monsanto Adipates for Testing

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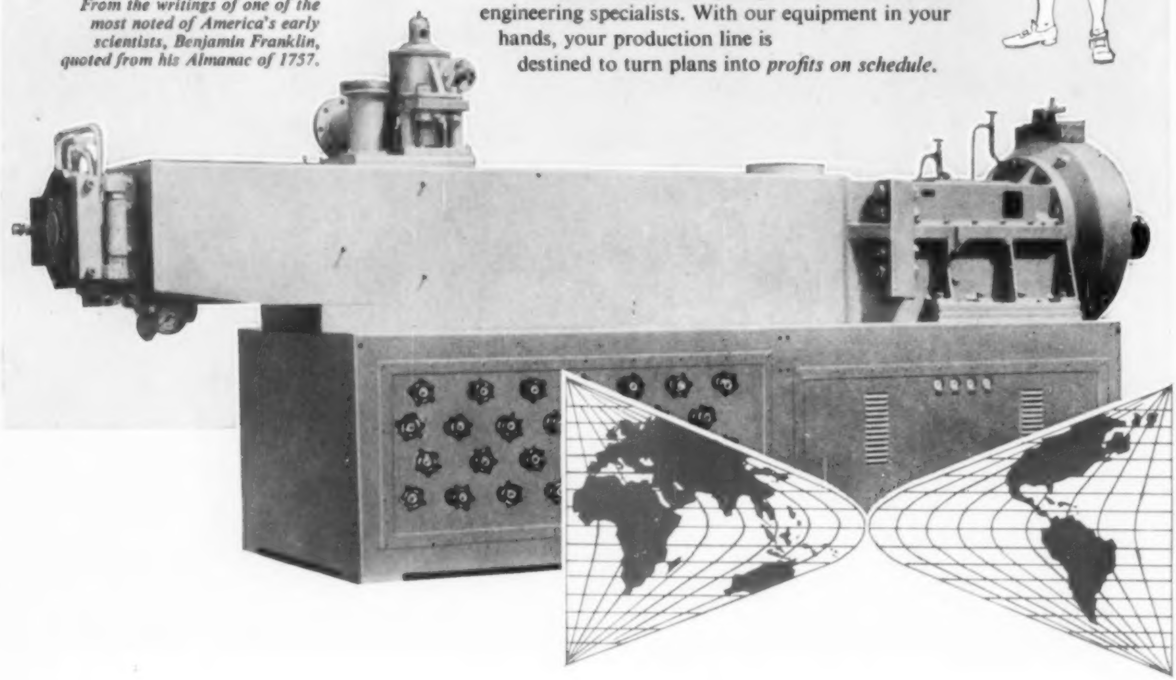
"The Eye of the master will do more work than both his hands"

From the writings of one of the most noted of America's early scientists, Benjamin Franklin, quoted from his Almanac of 1757.

The most versatile key to progress in the manufacture of plastics materials is thorough *understanding!* The very synonym of that all-important characteristic is the unique DUAL WORM design in the compounding-devolatilizing-extruding equipment developed by Welding Engineers. Here, indeed, is the "eye of the master", the capacity to see—and understand—the whole range of hard-to-handle materials including rubber and to maintain quality and rate "as promised and delivered" by Welding Engineers' research and engineering specialists. With our equipment in your hands, your production line is destined to turn plans into *profits on schedule.*



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High-clarity blown polyethylene film

By Joseph Pilaro† and Richard Kremer†

A method for improving the optical properties of blown polyethylene film by using a tubular annealing chamber has been studied. Theory of the technique is discussed and details of construction and positioning of the annealing chamber are given. Data are given showing how the annealing chamber affects resins of various melt indices and densities at various retention times. Limitations of the technique are also discussed.

In the extrusion of high polymers a surface roughness has been observed which has been ascribed to melt fracture.[1] The occurrence of melt fracture is dependent upon die geometry, shear rate, and molecular structure of the particular polymer involved.[2]

When extruding polyethylene into a shape such as pipe, or when coating wire, melt fracture is observed as surface imperfections. In the extrusion of blown polyethylene film, melt fracture is observed in certain polymers as poor gloss and clarity and high surface haze.

At given conditions of shear rate the degree to which melt fracture occurs is dependent upon the flow properties of the polymer. Surface roughness will decrease with increasing melt index or density, and with broadening molecular weight distribution[2]. If appearance were the only criterion, a good film resin would need high melt index, high density, and broad molecular weight distribution. However, other film properties such as toughness and stiffness must be considered when selecting a polyethylene resin for blown film; and, for a majority of resins, the resin properties which contribute to toughness impair optical properties.

Counteracting melt fracture

At our laboratories a successful attempt was made to counteract the effects of melt fracture and thus bring greater clarity and gloss to polyethylene films which were known primarily for their high strength characteristics. The mechanism used was the annealing chamber shown in Figs. 1 and 2, right.

By extruding blown tubing, through the annealing chamber, surface roughness caused by melt fracture was minimized. This has been attributed primarily to the increased amount of time that the extrudate was held at a temperature at which the polymer would flow. The flow taking place on the surface of the extrudate during

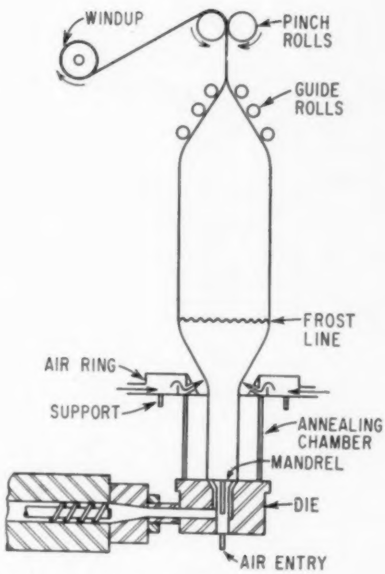

FIG. 1: Schematic diagram of the blown-film extrusion system together with annealing chamber.

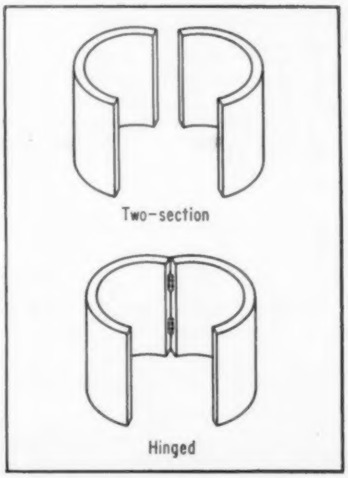

FIG. 2: Annealing chamber types.

*Reg. U. S. Pat. Off.

†Customer Service Engineers, Polymer Service Laboratories, U. S. Industrial Chemicals Co., Div. of National Distillers & Chemical Corp., Tuscola, Ill.

[1] J. P. Tordella, "Capillary Flow of Molten Polyethylene—A Photographic Study of Melt Fracture," Trans. of the Soc. of Rheology, Vol. I, 1957, pp. 203-212; and R. M. Schulken Jr., and R. E. Boy Jr., "Cause of Melt Fracture and Its Relation to Extrusion Behavior," SPE Tech. Papers, Vol. VI, 1960, pp. 82-1 to 82-5.

[2] D. R. Mills, G. E. Moore, and D. W. Pugh, "The Effect of Molecular Weight Distribution on the Flow Properties of Polyethylene," SPE Tech. Papers, Vol. VI, 1960, pp. 4-1 to 4-10.

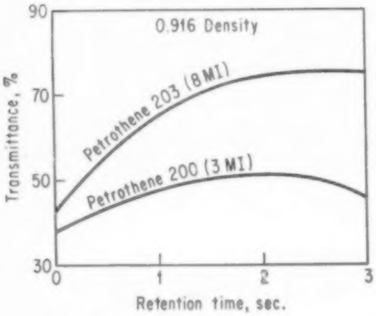

FIG. 3: Film transmittance as a function of retention time.

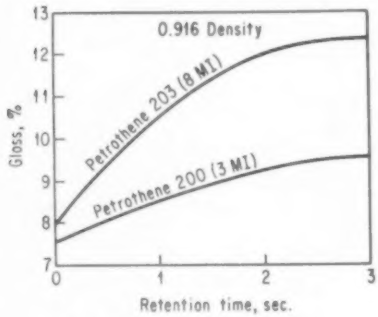

FIG. 4: Film gloss as a function of retention time.

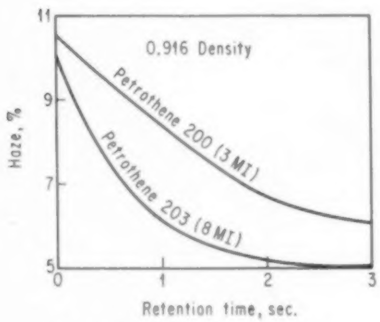

FIG. 5: Film haze as a function of retention time.

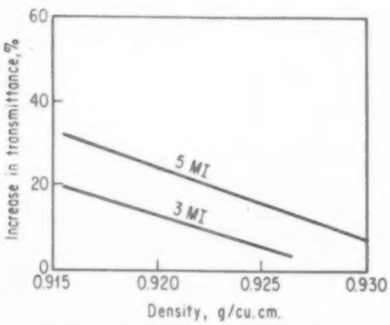

FIG. 6: Transmittance as a function of density at 1 sec. retention time for 3 and 5 melt index resins.

the annealing phase smoothed out the roughened areas of the film, improving both clarity and gloss. (See Table I, below, for resin and film properties dealt with in this article and test methods used.)

It has been suggested that the success of the chamber in improving optical properties is a result of controlled cooling through the crystalline melt point, thus increasing spherulite growth. This theory has been disproved by measuring the density of film produced under identical conditions with and without the annealing chamber. No significant change in film density was caused by the annealing chamber.

Retention of the extrudate at a temperature above the melting point for an extended period also tends to relax stresses in the films which have been formed in the die. This relaxation of stresses has been confirmed by observing the film under polarized light. Films produced without the annealing chamber were observed to be more oriented in the machine direction. The annealing chamber allowed relaxation in the extrudate, resulting in more balanced orientation in the transverse and machine directions. This phenomenon was further confirmed by Elmendorf tear testing of the film. Film extruded through the annealing chamber had a more balanced tear strength than film extruded without the chamber.

The annealing chamber is, therefore, held to serve two purposes. First, it smooths surface imperfections caused by melt fracture and second, it permits the relaxation of stresses in the film. The result is blown polyethylene tubing with improved optical properties and physical properties essentially unchanged except for the improvement in balance of molecular orientation and, consequently, in tear strength.

Construction and positioning of the chamber

The annealing chamber can be made of various materials such as cardboard, glass, or insulated

Table I: Test methods used in determining resin and film properties reported in this paper

Properties	*Units*	*Test method used*
Melt index	g./10 min.	ASTM D-1238-52T
Density	g./cu. cm.	Hydrostatic method
Film density	g./cu. cm.	ASTM D-1505-57T
Transmittance	%	USI method (low angle transmittance)
Gloss	%	ASTM D-523-53T
Haze	%	ASTM D-1003-52
Dart drop	g./f₅₀	Weight of dart required to break 1.5-mil film sample from 25-in. drop.
Elmendorf tear	g./mil	ASTM D-689-44

Table II: Effect on film properties[a] of annealing chamber diameter.

Resin	*Chamber diameter*	*Transmittance*	*Gloss*	*Haze*	*Dart drop*	*Elmendorf tear MD[b]*	*Elmendorf tear TD[c]*
	in.	*%*	*%*	*%*	*g.*	*g./mil*	*g./mil*
Petrothene 200 (3 M.I., 0.916 density)	No chamber	19	5.3	19.0	110	150	55
	8	48	8.1	8.3	285	40	100
	10	45	8.3	8.4	290	80	90
	12	43	8.1	9.4	285	50	105

[a] 2½ in. MPM Extruder with 4-in. die, haul-off speed 40 ft./min. to obtain these data.
[b] Property in machine direction.
[c] Property in direction transverse to machine direction.

Table III: Effect of retention time on optical and physical properties of blown tubing[a]

Retention time	Chamber height	Haul-off speed	Haze	Gloss	Transmittance	Dart drop	Elmendorf tear MD	Elmendorf tear TD
sec.	in.	ft./min.	%	%	%	g.	g./mil	g./mil
0	0	40	10.5	7.5	38	175	65	75
1	6	30	8.0	8.3	47	250	75	75
1	8	40	8.6	7.8	50	315	35	90
1	10	50	8.1	8.3	56	255	30	95
2	6	15	5.8	9.3	53	165	155	85
2	8	20	7.5	8.0	44	135	90	85
2.1	10	24	7.3	9.5	49	145	55	80
3	6	10	6.9	9.7	42	135	95	100
2.9	8	14	6.6	9.3	45	145	95	100
3.1	10	16	10.0	9.4	35	140	135	95

[a]All data obtained on 2½ in. MPM with 4-in. die and 330° F. extrusion stock temperature.

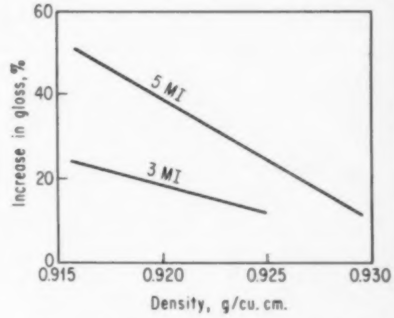

FIG. 7: Gloss as a function of density at 1 sec. retention time for 3 and 5 melt index resins.

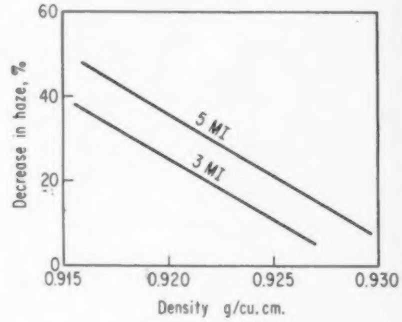

FIG. 8: Haze as a function of density at 1 sec. retention time for 3 and 5 melt index resins.

metal. Comparisons of chambers of identical size made from different materials showed little difference in optical improvements due solely to the material. Cardboard chambers lined with aluminum foil give slightly higher transmittance values than unlined chambers. This was attributed to the reflective surface of the foil and the resulting hotter annealing chamber atmosphere.

Cardboard cylinders with side walls ½ in. thick were used in most of the experimental runs described in this article. These cores are easily obtained in a variety of heights and diameters, and are thermally stable at normal die operating temperatures.

Constructing the chamber in two sections or hinged, as shown in Fig. 2, made it possible to position or remove it without breaking the film bubble.

The annealing chamber is positioned on the die with the air ring resting upon it. Although lightweight air rings may be supported by the chamber, it is recommended that independent supports be supplied, as indicated in Fig. 1. These may be connected to the die stand or to the haul-off canopy supports, depending on which is more convenient.

The chamber must be in a concentric position around the annular orifice of the die. The air ring must be parallel to the die face and concentrically located relative to the die orifice and the chamber. In order to minimize turbulence inside the chamber and to maintain a high temperature therein, the orifice diameter of the air ring should be slightly smaller than the inside diameter of the chamber.

The chamber diameter is not critical in its effect on film properties. However, excessively large chambers have been shown to prevent optimum improvement. (See Table II, left). Best results were obtained with a chamber diameter 2 to 3 in. larger than the die diameter.

The effect of film retention time and chamber heating

The height of the annealing chamber is one of variables in film retention time. Retention time is the period of time required for a cross section of film to travel from the die lips to the top of the annealing chamber during extrusion. It is calculated from the formula:

$$R = \frac{5C}{S} \qquad \text{Eq. 1}$$

where R = retention time (sec.), C = chimney height (in.), S = haul-off speed (ft./min.).

At a constant haul-off speed, retention time is increased as chimney height increases. At a constant chimney height, retention time is increased as haul-off speed slows down.

Figures 3 to 5, left, show the effect of increasing retention time on the optical properties of film produced from two Petrothene polyethylene film resins of the same density and different melt indexes. These graphs show that improvements in gloss, transmittance, and haze have a steep slope from zero retention time (no chimney) to 2 sec. retention time. At this point the rate of improvement begins to level. Therefore, from the standpoint of optical improvement, a retention time of 2 sec. appears optimum.

Of course, as is often the case, it is not possible from the output or production standpoint to run at optimum conditions. Commercial production speeds for other than ultra thin film would be in the range of 75 to 100 ft. per minute. Using Eq. 1 we find that a 2-sec. retention time and a haul-off speed of 75 ft./min. would require an annealing chamber 30 in. high. Equipment limitations prevented experimental runs with a chamber this tall, but work done with a 24-in. chamber showed that, while optical improvement was accom-

Table IV: Variation of film properties with melt index and density

Resin	Melt index	Density	Retention time	Haze	Gloss	Trans-mittance	Sand bag	Dart drop	Elmen. tear MD	Elmen. tear TD
	g./10 min.	g./cu. cm.	sec.	%	%	%	ft.	g.	g./mil	
Petrothene 239-27	5	0.929	1	7.6	11.8	72	1.5	80	140	105
			0	7.9	10.2	68	1	215	175	170
Petrothene 205	3	0.924	1	6.8	12.3	61	4	—	60	100
			0	7.9	10.9	54	1	—	165	145
Petrothene 200-28	3	0.916	1	6.8	9.3	67	7.5	85	40	75
			0	10.5	7.5	38	6	175	65	75
Petrothene 201	5	0.916	1	5.1	10.4	70	>9	255	45	65
			0	9.5	6.9	39	>9	280	60	45

plished, the short distance between molten film and nip roll (6 ft. on equipment used in this study) caused serious blocking of the warm film and marking of the film by nip rolls. Also, gage control was difficult to maintain.

Since significant optical improvement is obtained, and since much more realistic chamber heights and haul-off speeds are possible at a retention time of 1 sec., this seems to be optimum from the standpoint of production. The shorter retention time also appears significantly to increase impact strength as indicated by dart drop values in Table III, p. 117. Other film properties remain essentially unaffected by the annealing chamber, with the exception of Elmendorf tear strength which appears to balance its strength characteristics in the machine and transverse directions when the chamber is added. The results of Elmendorf tear testing were difficult to interpret due to poor reproducibility of this test.

Preliminary experiments have been made with heated annealing chambers in an attempt to increase the annealing effect at lower chamber heights. Although results are still inconclusive, it appears that when a heated chamber is used, shorter retention times may be used to obtain maximum optical improvements at faster haul-off speeds. Future work is planned to determine the full possibilities and to investigate how the shorter retention time affects film impact strength.

Basic resin properties and the annealing chamber

The optical properties of some polyethylene resins are more easily improved by means of the annealing chamber than others. A series of experiments was designed to determine improvement in optical properties as related to melt index and density. Standard conditions were established for all runs, using a 2½-in. MPM extruder with a 14:1 L/D ratio and a polyethylene-type screw. The blown tubing die was a 4-in. Hartig. The blow-up ratio was held at 2.2:1. Retention time in the annealing chamber was 1 sec., with the extrusion melt temperature maintained at 320° F. The frost line was held to 6 in. from the die, or 6 in. from the top of the annealing chamber, respectively.

The data obtained are shown in graph form in Figs. 6 to 8, pp. 116-117, as percent improvement in the properties. Both transmittance and gloss improve more for low-density resins than higher-density resins; these optical properties improve more for higher-melt index resins than for those with lower melt index. The annealing chamber decreased the haze of low-density resins more than higher-density resins. Higher melt index resins are improved in haze more than those with lower melt index.

Combining the information, it can be said that optical properties improve more with resins which normally have poorer optical properties. This is supported by the data in Table IV, above, which show a pronounced improvement in Petrothene 200 (3 M.I., 0.916 density) than in Petrothene 239 (5 M.I., 0.929 density).

One method often used commercially to improve optical properties is raising the frost line. Some benefit to the optical properties can thus be obtained. However, tear and impact strength are impaired. Control of wrinkles and gage is also very difficult.

An experiment was carried out with Petrothene 201, (5 M.I., 0.916 density) and Petrothene 203-28 (8 M.I., 0.916 density) to show the difference in optical properties of film made with the annealing chamber and film (To page 206)

Table V: Effects of frost line height and annealing chamber on certain properties

Resin	Frost line height	Trans-mittance	Gloss	Haze	Dart drop	Elmendorf tear MD	Elmendorf tear TD
	in.	%	%	%	g.	g./mil	
Petrothene 201	8[a]	39	6.9	9.5	280	60	45
(5/M.I., 0.916	20[a]	52	7.7	8.6	225	50	70
density)	20[b]	70	10.4	5.1	255	45	65
Petrothene 203-	8[a]	43	7.9	9.9	125	120	55
28 (8 M.I., 0.916	19[a]	46	7.5	9.1	130	110	60
density	20[b]	66	10.6	5.9	210	40	70

[a]Without annealing chamber.
[b]With 8 in. high annealing chamber.

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How to predict structural behavior of RP laminates

By Lawrence Fischer*

A layer of fibrous glass is assumed to behave structurally as an orthotropic material. On that basis, stress-strain relationships are presented for a single layer, and used to obtain the stress distribution in a laminate composed of many layers subjected to in-plane axial and shear stresses. The mathematical procedure is shown to be simplified for an isotropic laminate. An interaction equation is presented to predict failure of each layer in a laminate. A simple example is presented to clarify the mathematical procedure, and experimental data are shown to verify the accuracy of the theory.

With the increasing use of glass-fabric-base plastic laminates in aircraft, missile, and space structures, and in building and other types of construction, it is necessary to predict the structural behavior of such laminates with some degree of assurance.

Each layer of glass fabric in such a laminate has glass fibers that are generally oriented at right angles to each other (orthogonally) in the warp and fill directions, as shown in Figure 1A, right. The layer may have different numbers of glass fibers in the warp and fill directions, so that it is assumed to act as an orthotropic material, that is, a material having one set of properties in one direction, and another set at right angles to that direction not necessarily the same.

Two special types of orthotropic layers are shown in Figs. 1B and 1C. A crossplied layer has the same number of fibers in the warp and fill directions; a unidirectional layer has no fibers oriented in the fill direction.

A fibrous glass laminate is composed of individual layers whose warp directions are not necessarily oriented at the same angle with respect to each other.

This paper considers the structural behavior of fibrous glass laminates subjected to axial and shear loads with their loci in the plane of the laminate.

The following assumptions are made in this analysis:

1. A layer of glass fibers is elastic and homogeneous.
2. A layer of glass fibers is orthotropic.
3. Layers in a glass fibers laminate are connected by a material that has infinite shear rigidity.
4. Dimensions of a fibrous glass laminate are such that buckling will not occur.

A single layer of glass fibers is first considered. The applied axial and shear stresses f_x, f_y, f_{xy} are parallel to a pair of orthogonal axes x and y separated from the natural axes α and β parallel to the fibers by an angle ϕ, as shown in Fig. 2, right.

The stresses acting on a unit element of the layer are shown in Fig. 3, p. 122. These stresses may be resolved, as will be shown, into axial and shear stresses parallel to the α and β axes (see Fig. 3B). Due to the orthotropic nature of a layer of glass fibers the elastic constants, E, G, μ, and the ultimate axial and shear strengths are generally obtained parallel to the natural axes α and β (axes of warp and fill fibers). The relationship between stresses and strains in these directions in an orthotropic layer can be described mathematically by the following three equations.

Group 1:

$$\epsilon_\alpha = \frac{f_\alpha}{E_\alpha} - \mu_{\beta\alpha}\frac{f_\beta}{E_\beta} \qquad \text{Eq. 1}$$

$$\epsilon_\beta = \frac{f_\beta}{E_\beta} - \mu_{\alpha\beta}\frac{f_\alpha}{E_\alpha} \qquad \text{Eq. 2}$$

$$\epsilon_{\alpha\beta} = \frac{f_{\alpha\beta}}{G_{\alpha\beta}} \qquad \text{Eq. 3}$$

These equations may be solved for stresses f_α, f_β, $f_{\alpha\beta}$ in terms of strains ϵ_α, ϵ_β, $\epsilon_{\alpha\beta}$. The resulting set of equations is:

Group 2:

$$f_\alpha = \frac{E_\alpha}{\lambda}\epsilon_\alpha + \frac{E_\alpha \mu_{\beta\alpha}}{\lambda}\epsilon_\beta \qquad \text{Eq. 4}$$

$$f_\beta = \frac{E_\beta \mu_{\alpha\beta}}{\lambda}\epsilon_\alpha + \frac{E_\beta}{\lambda}\epsilon_\beta \qquad \text{Eq. 5}$$

$$f_{\alpha\beta} = G_{\alpha\beta}\,\epsilon_{\alpha\beta} \quad \text{where} \qquad \text{Eq. 6}$$

$$\lambda = 1 - \mu_{\alpha\beta}\,\mu_{\beta\alpha} \qquad \text{Eq. 7}$$

The relationship between

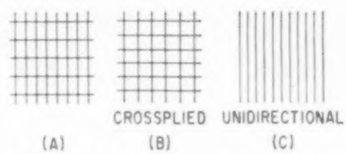

FIG. 1: Examples of orthogonal and orthotropic orientation of fibers in laminates. Letters are identified in text.

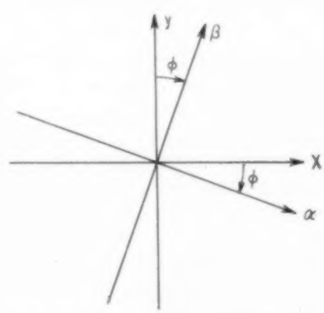

FIG. 2: Axes of **x** and **y** are directions of applied stress; α and β are natural axes of oriented fibers.

*Structural Development Engineer, Grumman Aircraft Engineering Corp., Bethpage, N. Y.

From a paper presented at the 15th Technical and Management Conference of the Reinforced Plastics Div. of S.P.I., Feb. 1960, Chicago, Ill.

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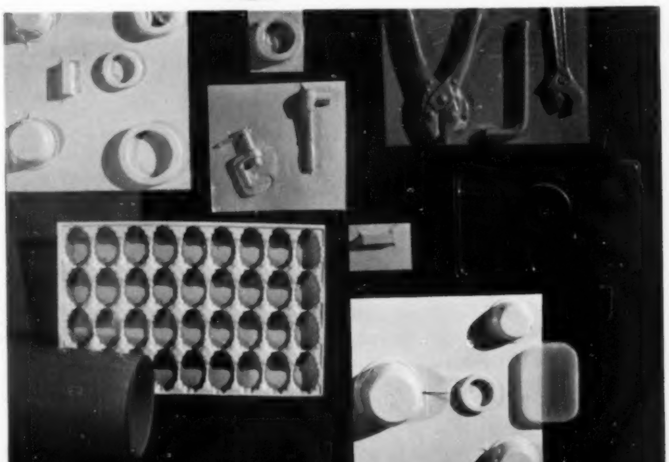

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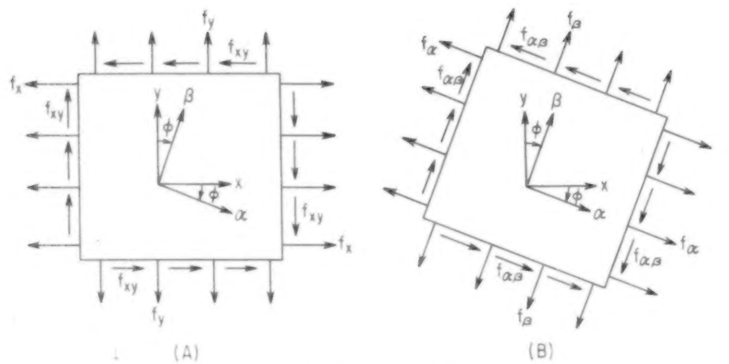

FIG. 3: Schematic of stresses acting on a unit element of a single fiber layer in a laminate.

stresses and strains in the x and y directions is:

$$\left.\begin{aligned} f_x &= b_{11}\,\epsilon_x + b_{12}\,\epsilon_y + b_{13}\,\epsilon_{xy} && \text{Eq. 8}\\ f_y &= b_{21}\,\epsilon_x + b_{22}\,\epsilon_y + b_{23}\,\epsilon_{xy} && \text{Eq. 9}\\ f_{xy} &= b_{31}\,\epsilon_x + b_{32}\,\epsilon_y + b_{33}\,\epsilon_{xy} && \text{Eq. 10}\end{aligned}\right\}\text{Group 3}$$

The coefficients b_{11}, b_{12}, . . . b_{33} are functions of the known elastic constants E_α, E_β, $G_{\alpha\beta}$, $\mu_{\alpha\beta}$, $\mu_{\beta\alpha}$ and the angle ϕ, as given in Basic Equations on p. 128.

Inversion of Group 2 of the equations results in the following set of equations, wherein the strains ϵ_x, ϵ_y, ϵ_{xy} are expressed in terms of the stresses f_x, f_y, f_{xy}.

$$\left.\begin{aligned} \epsilon_x &= a_{11}\,f_x + a_{12}\,f_y + a_{13}\,f_{xy} && \text{Eq. 11}\\ \epsilon_y &= a_{21}\,f_x + a_{22}\,f_y + a_{23}\,f_{xy} && \text{Eq. 12}\\ \epsilon_{xy} &= a_{31}\,f_x + a_{32}\,f_y + a_{33}\,f_{xy} && \text{Eq. 13}\end{aligned}\right\}\text{Group 4}$$

The coefficients a_{11}, a_{12}, . . . a_{33} are also defined on p. 128 in terms of b_{11}, b_{12}, . . . b_{33}. Groups 3 and 4 are derived (1)[1] and discussed elsewhere (3).

In order to evaluate the strains ϵ_α, ϵ_β, $\epsilon_{\alpha\beta}$, and thus obtain from Group 2 stresses f_α, f_β, $f_{\alpha\beta}$, the following set of equations (1) is

$$\left.\begin{aligned} \epsilon_\alpha &= \epsilon_x \cos^2\phi + \epsilon_y \sin^2\phi - \epsilon_{xy}\sin\phi\cos\phi && \text{Eq. 14}\\ \epsilon_\beta &= \epsilon_x \sin^2\phi + \epsilon_y \cos^2\phi + \epsilon_{xy}\sin\phi\cos\phi && \text{Eq. 15}\\ \epsilon_{\alpha\beta} &= 2(\epsilon_x - \epsilon_y)\sin\phi\cos\phi + \epsilon_{xy}(\cos^2\phi - \sin^2\phi) && \text{Eq. 16}\end{aligned}\right\}\text{Group 5}$$

Groups 2 through 5 will now be applied to determine the axial and shear stresses in each layer of a fibrous glass laminate subjected to total axial and shear stresses applied parallel to a set of orthogonal axes, x and y. Consider a glass fiber layer with the warp direction α_1, oriented such that it is separated from the x axis by an angle ϕ_1. Let another layer of glass fibers containing not necessarily the same glass fabric be placed on the first layer, oriented at an angle ϕ_2. Assume many layers similarly oriented, as shown in Fig. 4, p. 127.

By Assumption 3 given on page 120, the layers must deform together, and

$$\left.\begin{aligned} \epsilon_{x_1} &= \epsilon_{x_2} = \epsilon_{x_3} = \ldots \epsilon_{xN} && \text{Eq. 17}\\ \epsilon_{y_1} &= \epsilon_{y_2} = \epsilon_{y_3} = \ldots \epsilon_{yN} && \text{Eq. 18}\\ \epsilon_{xy_1} &= \epsilon_{xy_2} = \epsilon_{xy_3} = \ldots \epsilon_{xyN} && \text{Eq. 19}\end{aligned}\right\}\text{Group 6}$$

where N = number of layers.

The effective values of b_{11}, b_{12}, etc. for the composite laminate are the average values known for each layer (5).

$$\left.\begin{aligned} \overline{b_{11}} &= \frac{1}{T}\sum_{i=1}^{n} b_{11_i}\,t_i && \text{Eq. 20}\\ \overline{b_{12}} &= \overline{b_{21}} = \frac{1}{T}\sum_{i=1}^{n} b_{12_i}\,t_i && \text{Eq. 21}\end{aligned}\right\}\text{Group 7}$$

where t = thickness of each layer
T = total thickness of laminate
$\overline{b_{11}}$, $\overline{b_{12}}$, etc. are averages for the composite laminate b_{11_i}, b_{12_i}, etc. are defined on p. 128.

The average values, $\bar{a}_{11}$, $\bar{a}_{12}$, etc., for the composite laminate are obtained from $\overline{b}_{11}$, $\overline{b}_{12}$, etc. (see p. 128) and substituted in equations of Group 4 to obtain the strains ϵ_x, ϵ_y, ϵ_{xy} in terms of the known average stresses $\bar{f}_x$, $\bar{f}_y$, $\bar{f}_{xy}$ acting on the composite laminate. Equations of Group 5 are then applied to obtain the strains ϵ_α, ϵ_β, $\epsilon_{\alpha\beta}$, in each layer. Substituting ϵ_α, ϵ_β, $\epsilon_{\alpha\beta}$ in equations of Group 2, **(To page 127)**

[1] Numbers in parentheses link with references on p. 209.

Definitions of terms

Notation and sign convention (See Figure 3)

x and y axes:	any pair of orthogonal axes.
α and β axes:	orthogonal axes parallel to the natural axes (warp and fill) of a layer of fibrous glass.
ϕ:	angle between x and α axes, and y and β axes, measured clockwise from x to α and y to β.
$\bar{f}_x$, $\bar{f}_y$, $\bar{f}_{xy}$:	average axial and shear stresses applied to a laminate parallel to the x and y axes.
f_x, f_y, f_{xy}:	axial and shear stresses in a layer of fibrous glass parallel to the x and y axes.
f_α, f_β, $f_{\alpha\beta}$:	axial and shear stresses parallel to the natural axes α and β of a layer of fibrous glass.
ϵ_x, ϵ_y, ϵ_{xy}:	axial and shear strains per unit length parallel to the x and y axes.
ϵ_α, ϵ_β, $\epsilon_{\alpha\beta}$:	axial and shear strains per unit length parallel to the natural axes α and β.
E_α, E_β:	moduli of elasticity of a layer of fibrous glass, parallel to the natural axes α and β respectively.
$G_{\alpha\beta}$:	modulus of rigidity of a layer of fibrous glass, parallel to the natural axes α and β.
$\mu_{\alpha\beta}$, $\mu_{\beta\alpha}$:	Poisson's ratios (first subscript refers to direction of stress; second subscript refers to direction of strain) parallel to the natural axes α and β.
F_α, F_β, $F_{\alpha\beta}$:	ultimate axial and shear stresses of a fibrous glass layer parallel to the natural axes α and β.
Subscript i:	particular layer of a fibrous glass laminate.

Sign Convention: Tensile stresses and strains are positive. Compressive stresses and strains are negative. Angles measured clockwise from x to α axes are positive.

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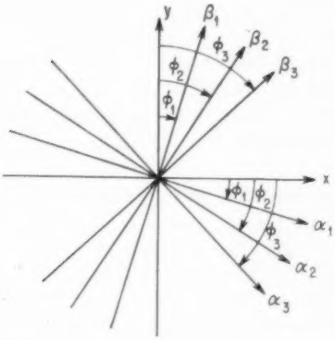

FIG. 4: Analysis of several layers of fibers in a laminate.

the axial and shear stresses for f_α, f_β and $f_{\alpha\beta}$ are obtained for each layer of the laminate.

Isotropic laminate

The previous discussion considers the general case of unrestricted layer orientation. If the layers have the same glass fabric and are oriented such that the number of layers N is three or more and the angle between the warp directions of adjacent layers is equal to π/N, we have an isotropic laminate (properties same in all directions). The procedure that has been previously described for determining f_α, f_β, $f_{\alpha\beta}$ in each layer of a laminate is then simplified.

The values of $\overline{b}_{11}$, $\overline{b}_{12}$, etc. in equations of Group 7 and the corresponding values of $\overline{a}_{11}$, $\overline{a}_{12}$, etc. become independent of ϕ (5), and the stress-strain relationship equations of Group 4 reduce to:

$$\left.\begin{aligned} \epsilon_x &= \frac{\overline{f}_x}{\overline{E}} - \overline{\mu}\,\frac{\overline{f}_y}{\overline{E}} && \text{Eq. 22} \\ \epsilon_y &= \frac{\overline{f}_y}{\overline{E}} - \overline{\mu}\,\frac{\overline{f}_x}{\overline{E}} && \text{Eq. 23} \\ \gamma_{xy} &= \frac{\overline{f}_{xy}}{\overline{G}} && \text{Eq. 24} \end{aligned}\right\}\text{Group 8}$$

where

$$\overline{E} = \frac{1-\overline{\mu}^2}{\lambda}\left[\frac{3}{8}E_\alpha + \frac{3}{8}E_\beta + \frac{1}{8}(2E_\alpha\mu_{\beta\alpha} + 4\lambda G_{\alpha\beta})\right] \quad \text{Eq. 25}$$

$$\overline{\mu} = \frac{E_\alpha + E_\beta + 6E_\alpha\mu_{\beta\alpha} - 4\lambda G_{\alpha\beta}}{3E_\alpha + 3E_\beta + 2E_\alpha\mu_{\beta\alpha} + 4\lambda G_{\alpha\beta}} \quad \text{Eq. 26}$$

$$\overline{G} = \frac{1}{\lambda}\left[\frac{1}{8}(E_\alpha + E_\beta - 2E_\alpha\mu_{\beta\alpha}) + \frac{1}{2}G_{\alpha\beta}\right] \quad \text{Eq. 27}$$

The derivation of $\overline{E}$, $\overline{\mu}$, $\overline{G}$ is found in (5). Equations of Group 8 eliminate the necessity of obtaining values of b_{11_1}, b_{12_1}, etc. for each layer when the laminate is isotropic. The values of ε_x, ε_y, ε_{xy} are substituted in equations of Group 5 to obtain ε_α, ε_β, $\varepsilon_{\alpha\beta}$ for each layer. Equations of Group 2 are then applied to obtain the stresses f_α, f_β, $f_{\alpha\beta}$ in each layer.

Laminate failure

As determined by tests (3), (6), (7), (8), laminate failure occurs before the ultimate strengths F_α, F_β, $F_{\alpha\beta}$ are obtained. An equation based on the distortion energy strength criteria was derived (4) and extended at Grumman (to include different elastic constants in the warp and fill directions) to predict failure of any layer in a fibrous glass laminate. The equation, which considers interaction of the axial and shear stresses, is

$$1 = \frac{(f_\alpha)^2}{(F_\alpha)} + \frac{(f_\beta)^2}{(F_\beta)} + \frac{(f_{\alpha\beta})^2}{(F_{\alpha\beta})} - K\,\frac{f_\alpha\, f_\beta}{F_\alpha\, F_\beta} \quad \text{Eq. 28}$$

where

$$K = \frac{E_\alpha\,(1+\mu_{\beta\alpha}) + E_\beta\,(1+\mu_{\alpha\beta})}{2\sqrt{E_\alpha\, E_\beta\,(1+\mu_{\alpha\beta})\,(1+\mu_{\beta\alpha})}}$$

Since the laminate is a monolithic structure, laminate failure will occur at a value of applied stress higher than the value required to cause failure of the weakest layer. This is seen by comparing the experimental and computed values in **Fig. 7, p. 128.**

A typical case

A fibrous glass laminate is composed of 12 layers of Type 181 glass fabric; six layers have their warp directions oriented parallel to the x axis, and six layers are oriented 45° from the x axis (see Fig. 5, below).

The laminate is subjected to tensile stresses applied parallel to the x axis. Based on the material properties given in the following equations, the strength of the laminate will be determined.

$F_{\alpha_1} = F_{\alpha_2} = 45{,}000$ p.s.i.	Eq. 30
$F_{\beta_1} = F_{\beta_2} = 42{,}400$ p.s.i.	Eq. 31
$F_{\alpha\beta_1} = F_{\alpha\beta_2} = 14{,}000$ p.s.i.	Eq. 32
$E_{\alpha_1} = E_{\alpha_2} = 2.88 \times 10^6$ p.s.i.	Eq. 33
$E_{\beta_1} = E_{\beta_2} = 2.66 \times 10^6$ p.s.i.	Eq. 34
$G_{\alpha\beta_1} = G_{\alpha\beta_2} = 0.810 \times 10^6$ p.s.i.	Eq. 35
$\mu_{\alpha\beta_1} = \mu_{\alpha\beta_2} = 0.17$	Eq. 36
$\mu_{\beta\alpha_1} = \mu_{\beta\alpha_2} = 0.16$	Eq. 37
$t_1 = t_2 = 0.0625$	Eq. 38
$\phi_1 = 0^\circ$	Eq. 39
$\phi_2 = 45^\circ$	Eq. 40

The values of b_{11}, b_{12}, etc. for each layer **are:**

$b_{11_1} = 2.96 \times 10^6$	Eq. 41
$b_{12_1} = b_{21_1} = 0.468 \times 10^6$	Eq. 42
$b_{13_1} = b_{31_1} = 0$	Eq. 43

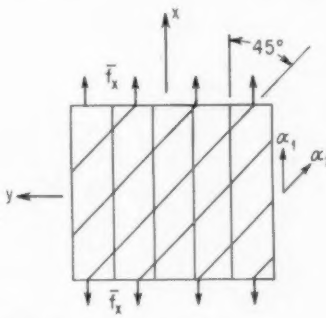

FIG. 5: Analysis of a glass fiber laminate composed of 12 layers of Type 181 glass fabric (see example in text).

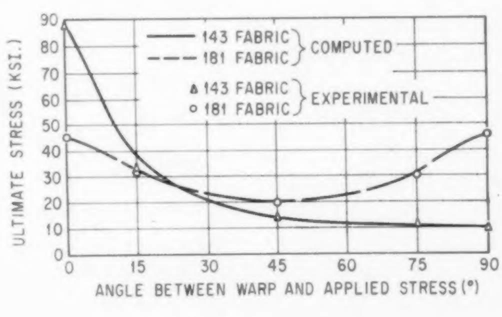

FIG. 6: Relationship between the ultimate stress and angle between warp and applied stress, showing agreement between computed and experimental data.

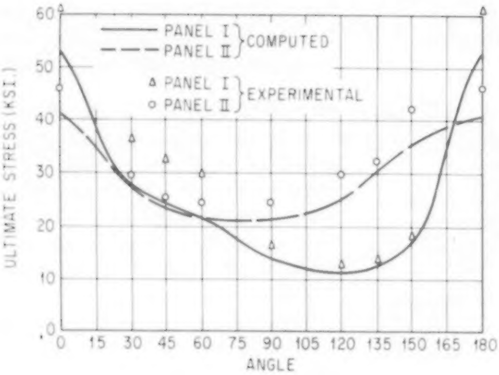

FIG. 7: Relationship between ultimate stress and angle between axes of reference and applied stress.

$b_{22_1} = 2.76 \times 10^6$ Eq. 44
$b_{23_1} = b_{32_1} = 0$ Eq. 45
$b_{33_1} = 0.810 \times 10^6$ Eq. 46
$b_{11_2} = 2.48 \times 10^6$ Eq. 47
$b_{12_2} = b_{21_2} = 0.851 \times 10^6$ Eq. 48
$b_{13_2} = b_{31_2} = 0.0514 \times 10^6$ Eq. 49
$b_{22_2} = 2.48 \times 10^6$ Eq. 50
$b_{23_2} = b_{32_2} = -0.0514 \times 10^6$ Eq. 51
$b_{33_2} = 1.19 \times 10^6$ Eq. 52

From the equations of Group 7 the average values of b_{11}, b_{12}, etc. for the composite laminate are:

$\bar{b}_{11} = 2.76 \times 10^6$ Eq. 53
$\bar{b}_{12} = \bar{b}_{21} = 0.660 \times 10^6$ Eq. 54
$\bar{b}_{13} = \bar{b}_{31} = -0.0257 \times 10^6$ Eq. 55
$\bar{b}_{22} = 2.62 \times 10^6$ Eq. 56
$\bar{b}_{23} = \bar{b}_{32} = 0.0257 \times 10^6$ Eq. 57
$\bar{b}_{33} = 1.000 \times 10^6$ Eq. 58

The values of $\bar{a}_{11}$, $\bar{a}_{12}$, etc. are then determined (right).

$\bar{a}_{11} = 0.394 \times 10^{-6}$ Eq. 59
$\bar{a}_{12} = \bar{a}_{21} = -0.0990 \times 10^{-6}$ Eq. 60
$\bar{a}_{13} = \bar{a}_{31} = 0.00757 \times 10^{-6}$ Eq. 61
$\bar{a}_{22} = 0.409 \times 10^{-6}$ Eq. 62
$\bar{a}_{23} = \bar{a}_{32} = 0.00796 \times 10^{-6}$ Eq. 63
$\bar{a}_{33} = 1.004 \times 10^{-6}$ Eq. 64

The values of $\bar{a}_{11}$, $\bar{a}_{12}$, etc. are substituted in equations of Group 4 to obtain ε_x, ε_y, ε_{xy}.

$\epsilon_x = 0.394 \times 10^{-6}\,\bar{f}_x$ Eq. 65
$\epsilon_y = 0.0990 \times 10^{-6}\,\bar{f}_x$ Eq. 66
$\epsilon_{xy} = -.00757 \times 10^{-6}\,\bar{f}_x$ Eq. 67

Substituting in equations of Group 5, we obtain:

$\epsilon_{\alpha_1} = 0.394 \times 10^{-6}\,\bar{f}_x$ Eq. 68
$\epsilon_{\beta_1} = 0.0990 \times 10^{-6}\,\bar{f}_x$ Eq. 69
$\epsilon_{\alpha\beta_1} = 0.00757 \times 10^{-6}\,\bar{f}_x$ Eq. 70
$\epsilon_{\alpha_2} = 0.144 \times 10^{-6}\,\bar{f}_x$ Eq. 71
$\epsilon_{\beta_2} = 0.152 \times 10^{-6}\,\bar{f}_x$ Eq. 72
$\epsilon_{\alpha\beta_2} = 0.493 \times 10^{-6}\,\bar{f}_x$ Eq. 73

Substituting in equations of Group 1, we obtain:

$f_{\alpha_1} = 1.120\,\bar{f}_x$ Eq. 74
$f_{\beta_1} = 0.0874\,\bar{f}_x$ Eq. 75
$f_{\alpha\beta_1} = 0.00613\,\bar{f}_x$ Eq. 76
$f_{\alpha_2} = 0.497\,\bar{f}_x$ Eq. 77
$f_{\beta_2} = 0.468\,\bar{f}_x$ Eq. 78
$f_{\alpha\beta_2} = 0.400\,\bar{f}_x$ Eq. 79

Thus, the stress distribution in each layer is obtained in terms of the average applied stress $\bar{f}_x$. The interaction equations (Eq. 28 and 29) are then applied to determine the maximum average applied stress $\bar{F}_x$ that will cause failure of each layer.

$\bar{F}_{x_1} = 40{,}200$ p.s.i. Eq. 80
$\bar{F}_{x_2} = 32{,}600$ p.s.i. Eq. 81

The two values indicate that when $\bar{F}_x = 32{,}600$ p.s.i., a stress redistribution occurs and failure will be caused by a stress greater than 32,600 p.s.i. and less than 40,200 p.s.i.

Discussion and conclusions

Accuracy of mathematical theory: The validity of the assumptions made in the mathematical theory is dependent on the many material variables that are intrinsic to the composition of fibrous glass. Fibrous glass is not homogeneous, since the glass fibers do not occupy exactly the same locations throughout the laminate. Although the glass fibers are elastic, stresses applied at an angle other than parallel to the warp or fill directions do not result in elastic behavior.

The assumption that a layer of glass fibers acts as an orthotropic material also depends on the homogeneity and elasticity of the material. Assumption 3, which is given on p. 120, **(To page 208)**

Basic Equations

The equations for b_{11}, b_{12}, etc. determine the coefficients in equations of Group 2. The expressions for a_{11}, a_{12}, etc. determine the coefficients in equations in Group 3.

$$b_{11} = \frac{1}{\lambda}\left[E_\alpha \cos^4\phi + E_\beta \sin^4\phi + (2E_\alpha\,\mu_{\beta\alpha} + 4\,\lambda\,G_{\alpha\beta})\sin^2\phi\cos^2\phi\right]$$

$$b_{12} = b_{21} = \frac{1}{\lambda}\left[(E_\alpha + E_\beta - 4\,\lambda\,G_{\alpha\beta})\sin^2\phi\cos^2\phi + E_\alpha\,\mu_{\beta\alpha}(\cos^4\phi + \sin^4\phi)\right]$$

$$b_{13} = b_{31} = \frac{1}{\lambda}\left[(E_\beta - E_\alpha\,\mu_{\beta\alpha} - 2\,\lambda\,G_{\alpha\beta})\sin^3\phi\cos\phi - (E_\alpha - E_\alpha\,\mu_{\beta\alpha} - 2\,\lambda\,G_{\alpha\beta})\sin\phi\cos^3\phi\right]$$

$$b_{22} = \frac{1}{\lambda}\left[E_\beta \cos^4\phi + E_\alpha \sin^4\phi + (2E_\alpha\,\mu_{\beta\alpha} + 4\,\lambda\,G_{\alpha\beta})\sin^2\phi\cos^2\phi\right]$$

$$b_{23} = b_{32} = \frac{1}{\lambda}\left[(E_\beta - E_\alpha\,\mu_{\beta\alpha} - 2\,\lambda\,G_{\alpha\beta})\sin\phi\cos^3\phi - (E_\alpha - E_\alpha\,\mu_{\beta\alpha} - 2\,\lambda\,G_{\alpha\beta})\sin^3\phi\cos\phi\right]$$

$$b_{33} = \frac{1}{\lambda}\left[(E_\alpha + E_\beta - 2E_\alpha\,\mu_{\beta\alpha})\sin^2\phi\cos^2\phi + \lambda\,G_{\alpha\beta}(\cos^2\phi - \sin^2\phi)^2\right]$$

where $\lambda = 1 - \mu_{\alpha\beta}\,\mu_{\beta\alpha}$

$$a_{11} = \frac{b_{22}\,b_{33} - b_{23}^2}{B} \qquad a_{22} = \frac{b_{11}\,b_{33} - b_{13}^2}{B}$$

$$a_{12} = \frac{b_{13}\,b_{23} - b_{12}b_{33}}{B} = a_{21} \qquad a_{23} = \frac{b_{13}\,b_{12} - b_{11}\,b_{23}}{B} = a_{32}$$

$$a_{13} = \frac{b_{12}\,b_{23} - b_{13}\,b_{22}}{B} = a_{31} \qquad a_{33} = \frac{b_{11}\,b_{22} - b_{12}^2}{B}$$

where $B = b_{11}b_{22}b_{33} - b_{11}b_{23}^2 + 2b_{12}b_{23}b_{13} - b_{12}^2b_{33} - b_{13}^2b_{22}$

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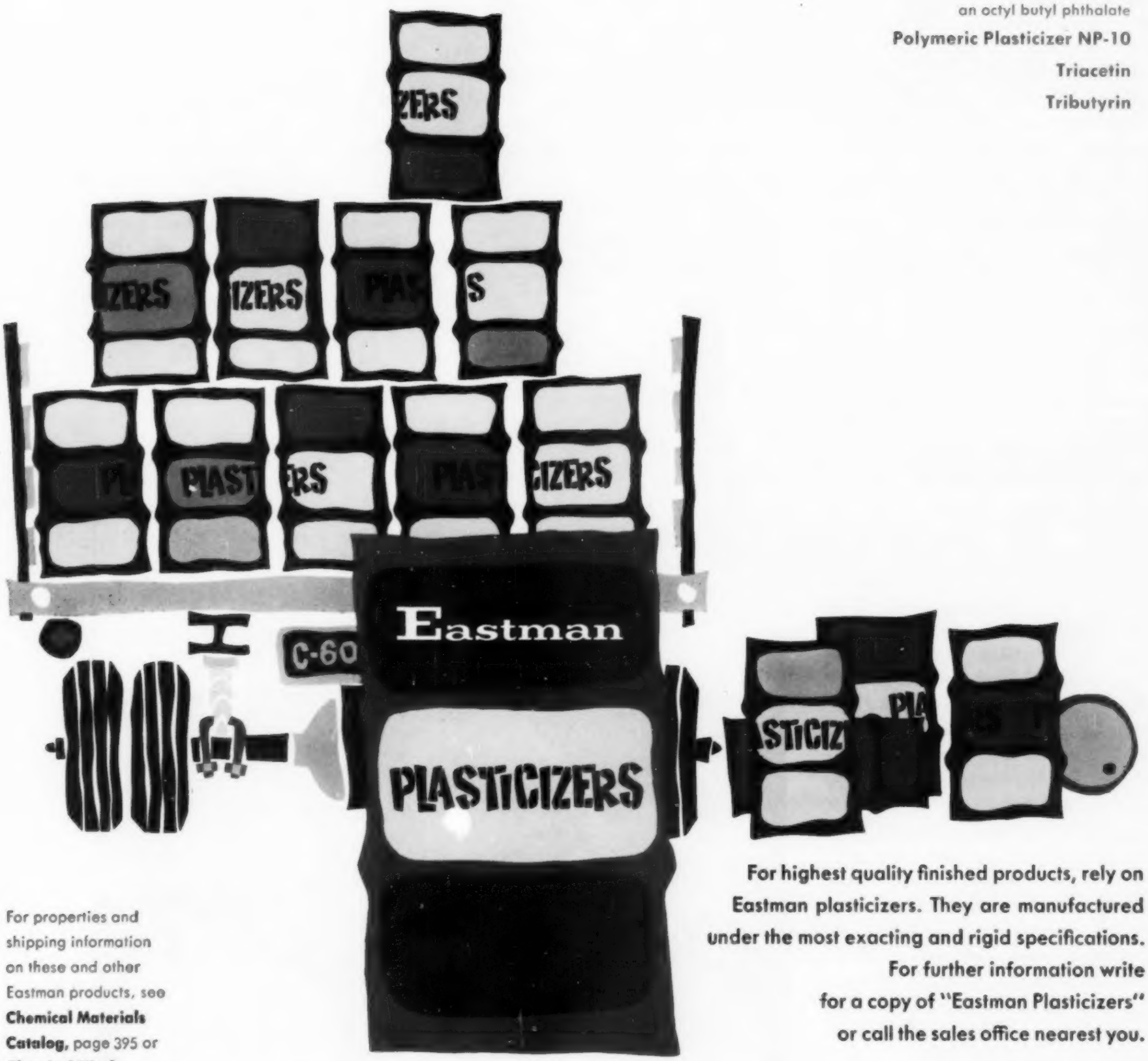

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Design tips for polyolefin parts

How to overcome molding defects in polyolefin parts through proper design

By J. N. Scott*, J. V. Smith*, and D. L. Alexander*

The term polyolefin, as applied to commercially available thermoplastic resins, covers several basic types of materials, including low-, medium-, and high-density polyethylenes, ethylene copolymers, and "isotactic" polypropylene, the most recent addition to this basic resin group. End products vary from soft and flexible to much harder, rigid items. Subdividing even further, we find a wide variety of resin grades specially tailored to do the best job in a specific application. For example, certain linear polyethylene resins have been tailored to meet the stringent requirements of metal insert molding, automotive applications and safety helmets while others have been produced with less toughness to achieve the high flow required for the disposable packages. With such a broad range of properties and applications, the subject of part design can only be treated broadly here.

Polyolefins, while differing among each other considerably in some properties, are all dependent on crystallinity for rigidity, strength, and many other desirable properties. The comparatively high shrinkage normally associated with these resins is also attributable to partial crystallization. The degree of crystallinity in turn, is somewhat dependent on the cooling rate of the molded part; one area of an item, if cooled more slowly than another, will reach a higher percentage crystallinity and exhibit greater shrinkage. This possibility of non-uniform shrinkage is perhaps the most important characteristic to be considered in designing polyolefin items.

Distortion of flat section

Undoubtedly, the chief problem encountered in injection molding polyolefin resins has been distortion of items having large flat sections. Investigations have revealed that these problems have usually resulted from small differences in shrinkage over the area of the item. This lack of uniform shrinkage reflects inadequate or improper cooling, a high degree of molecular orientation in the gate area, or packing of excessive resin into certain sections of the part.

Much progress has been made in overcoming distortion of polyolefin items through proper mold design, improved equipment, correct molding procedures and new resin developments. However, even with these advances, difficulty is still occasionally encountered with certain types of items, primarily those having large flat sections. Although it may be possible to injection mold this type of item, it is difficult to maintain the precise balance of conditions necessary to produce a perfectly flat part. A very slight "molded-in" stress, a small amount of packing, improper ejection, or even subsequent handling can cause distortion.

Rigidity can be achieved, product quality improved, and the molding operation simplified by incorporating certain features in the

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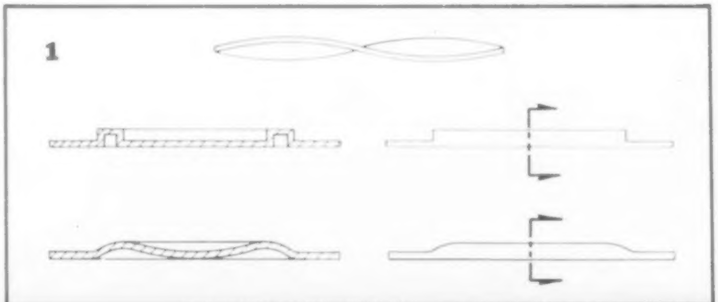
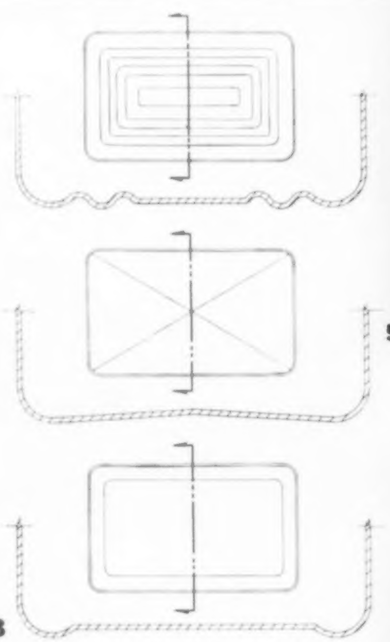


FIG. 1: Geometrical designs which improve rigidity and eliminate warpage in flat sections. **FIG. 2:** Molded items in which the principles shown in Fig. 1 have been applied to eliminate warpage. 2



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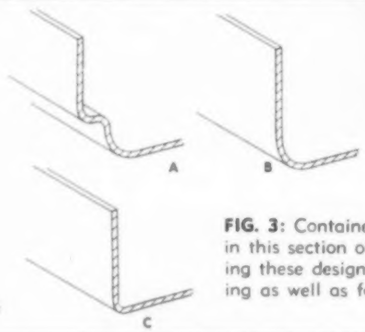

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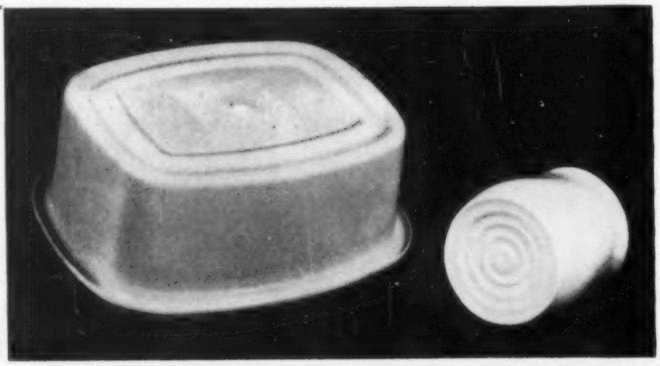

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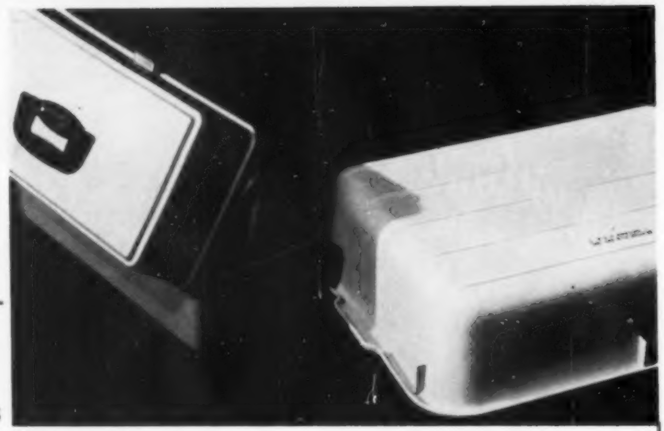

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FIGS. 5 AND 6: Four parts showing good bottom and bottom corner design.

FIG. 3: Container bottoms showing how design is used to eliminate warpage in this section of the part. **FIG. 4:** Edges at the bottom of containers showing these designs. Letters indicate the order of preference for ease of molding as well as for the quality of the product.

design of most items that are to be produced from polyolefin resins. It is well known that the majority of polyolefin items, such as centergated bowls, tumblers, etc., exhibit no tendency to warp. Generally, the geometry lends rigidity and is not subject to distortion by minor variations in shrinkage over the part. It follows that in designing an item for a polyolefin resin, it is desirable: 1) to avoid large flat sections, 2) to use features that allow relief of minor stresses, and 3) to incorporate as much structural rigidity as possible. Many of these features also add to the appearance and serviceability.

Geometric considerations

There are many examples of "flat" polyolefin items now in production. Almost invariably the secret to success is that 1) features have been incorporated to make the item very rigid or 2) although appearing flat, the part is designed with compound radii and actually has no perfectly flat surfaces. Figure 1, p. 130, illustrates satisfactory features for this type part and Fig. 2, p. 130, is a photograph of a few of such items.

The seat is an excellent example. This item is much easier to produce and is more attractive and functional than it would have been if patterned after the much flatter wooden seats. Similarly, the large flat disk of the Jeri Wheel or the prune jar lid would, likewise, be very difficult to produce warp free without the reinforcement of the perpendicular cylindrical section.

The simple change in plane of the dust pan bottom does much to increase the rigidity of this otherwise very flexible section.

Container bottoms

Perhaps one of the more important areas for consideration in designing many container type items is the bottom. This has traditionally been a flat section, often proportionally large, and is usually the most practical area for gate location. Warpage of polyolefin items can occur in this area or as a result of excessive shrinkage of this section. Fig. 3, above, shows certain features that, if properly employed, can circumvent these problems. The corrugated section is ideal in that rigidity is achieved and the strain that might develop from non-uniform shrinkage can be relieved without distorting the

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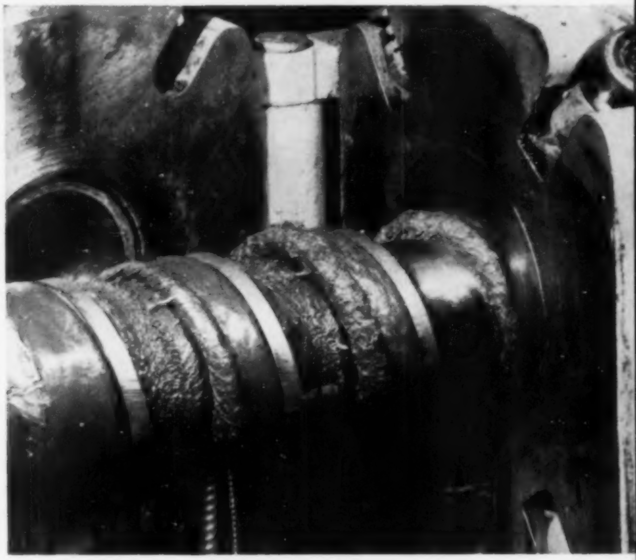
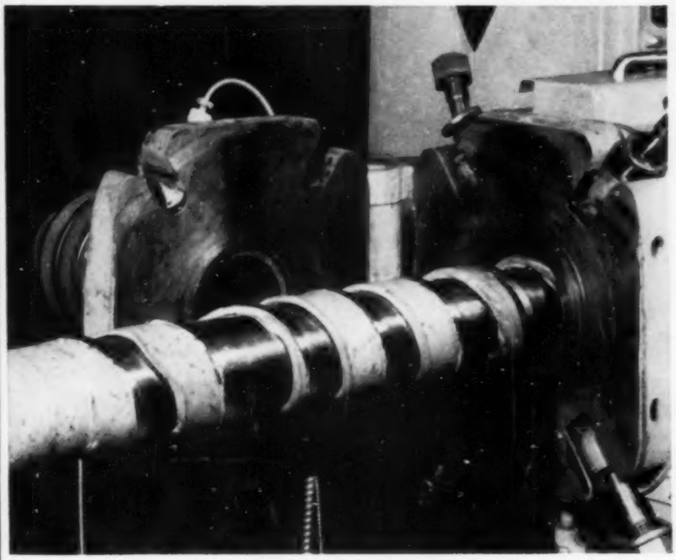


2. Operate machine to purge old material.



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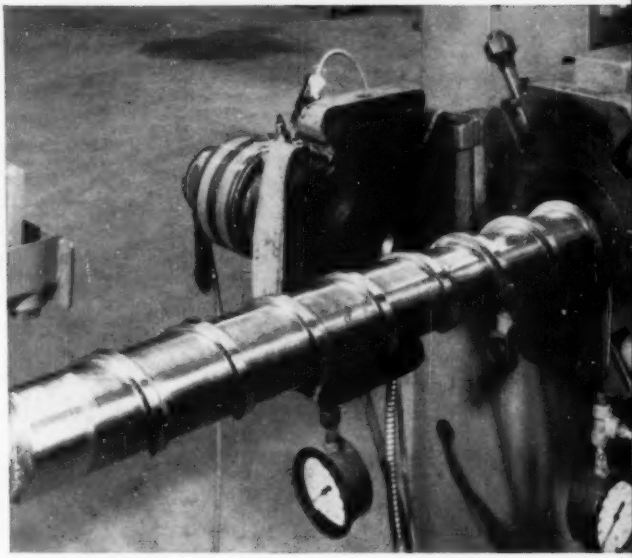

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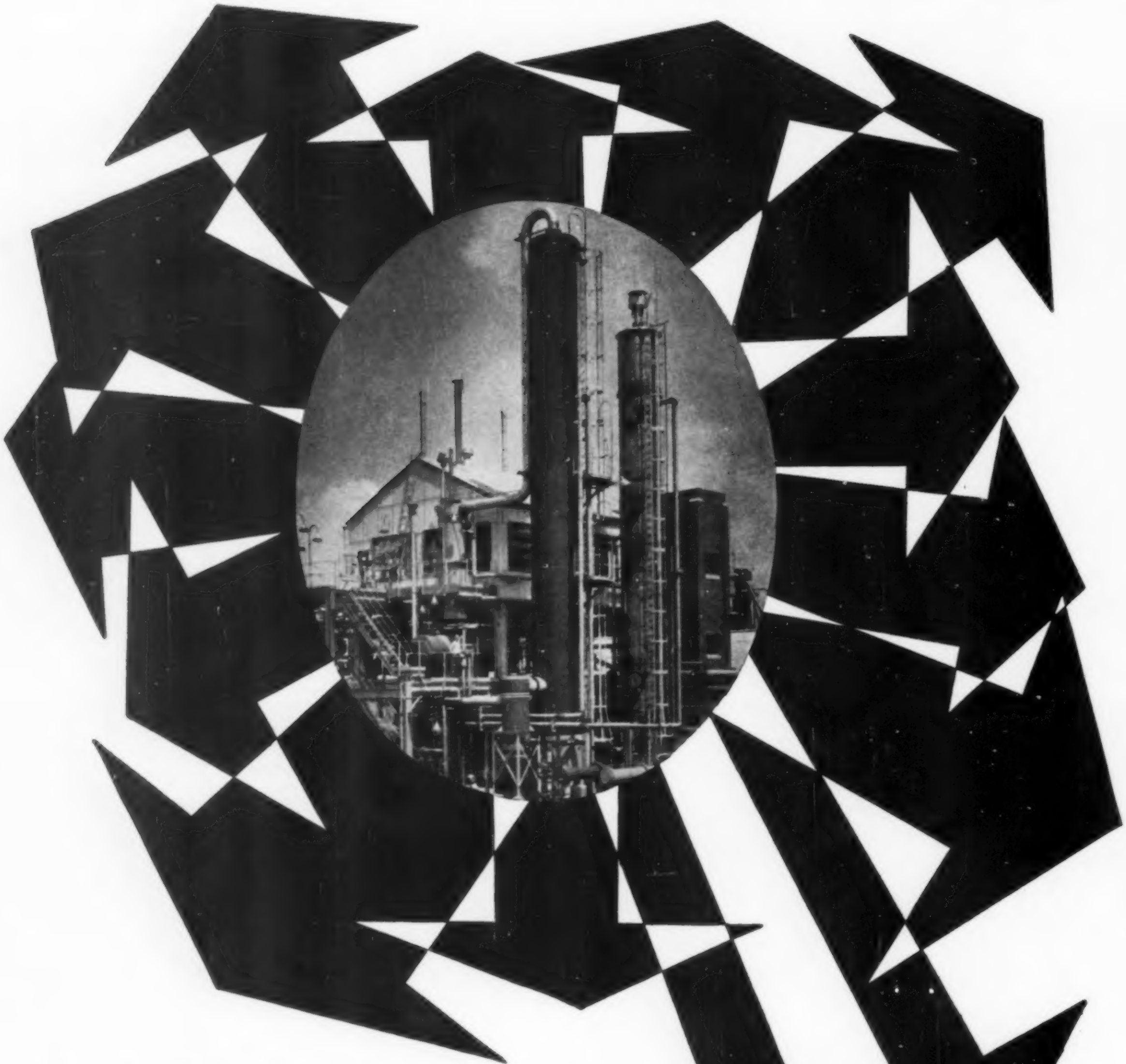

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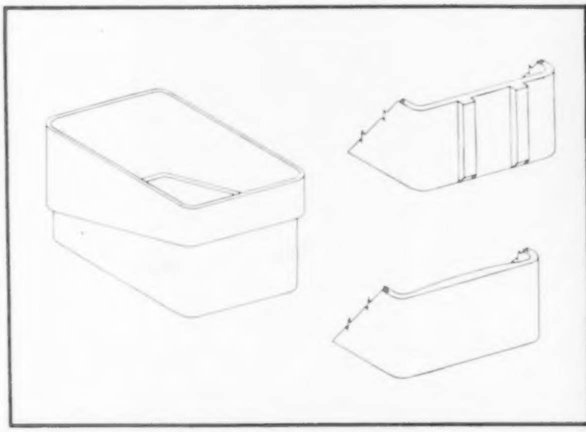

FIG. 7: Side wall designs for containers which help balance out differential shrinkages and prevent buckling of long flat sidewalls.

FIG. 8: Molded parts showing good side wall design. Notice the freedom from buckling, as is evidenced by the clean lines of the step sections.

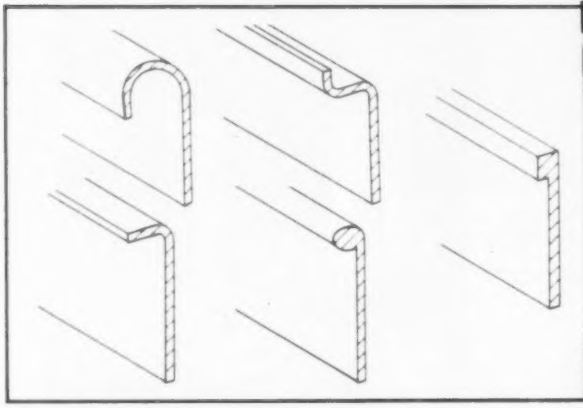

FIG. 9: Lip designs which are used to improve the rigidity of the open edges of molded parts.

FIG. 10: Molded parts showing good lip design. Parts shown are dishpan, baby bath tub, and various bowls.

part. Pyramid, crowned, or offset sections allow for strain relief without deforming other sections of the item.

It is important to use as large bottom corner radii as possible in combination with these "bottom" features. A step, or offset, is also a plus factor where it can be employed. Figure 4, p. 132, illustrates bottom corner designs in the order of preference from the standpoint of molding ease and product quality. Figures 5 and 6, p. 132, are photographs of some of the products employing these recommended features.

Side wall designs

Another important area in the design of containers or box-like items is the side wall section. Optimum quality with this type of product is achieved only when wall sections are rigid and have shrinkage equal to that of the bottom section. Figure 7, above, illustrates the use of a stepped or thickened center sections to increase rigidity and induce the additional shrinkage that is usually needed to prevent buckling of a long flat side wall. Figure 8, above, is a photograph of items with these design features. In addition to providing rigidity to the parts, the intelligent use of the wall designs also contributes novelty to the parts' appearance as well.

Lips and edges

Inadequate rigidity in the edge or lip section of a high-density polyethylene item distracts from utility and often leads to a wavy appearance. The commonly used thick bead actually aggravates distortion problems. It **(To page 207)**

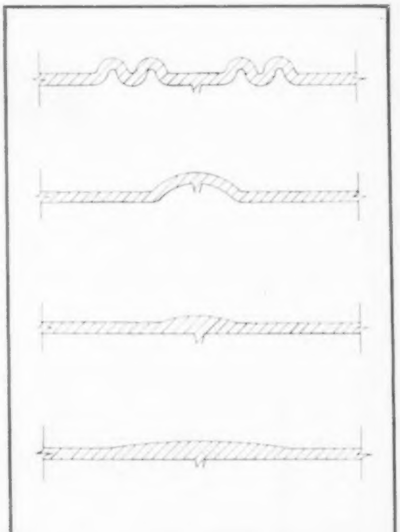

FIG. 11: Recommended part designs for the gate area of molded polyolefins.

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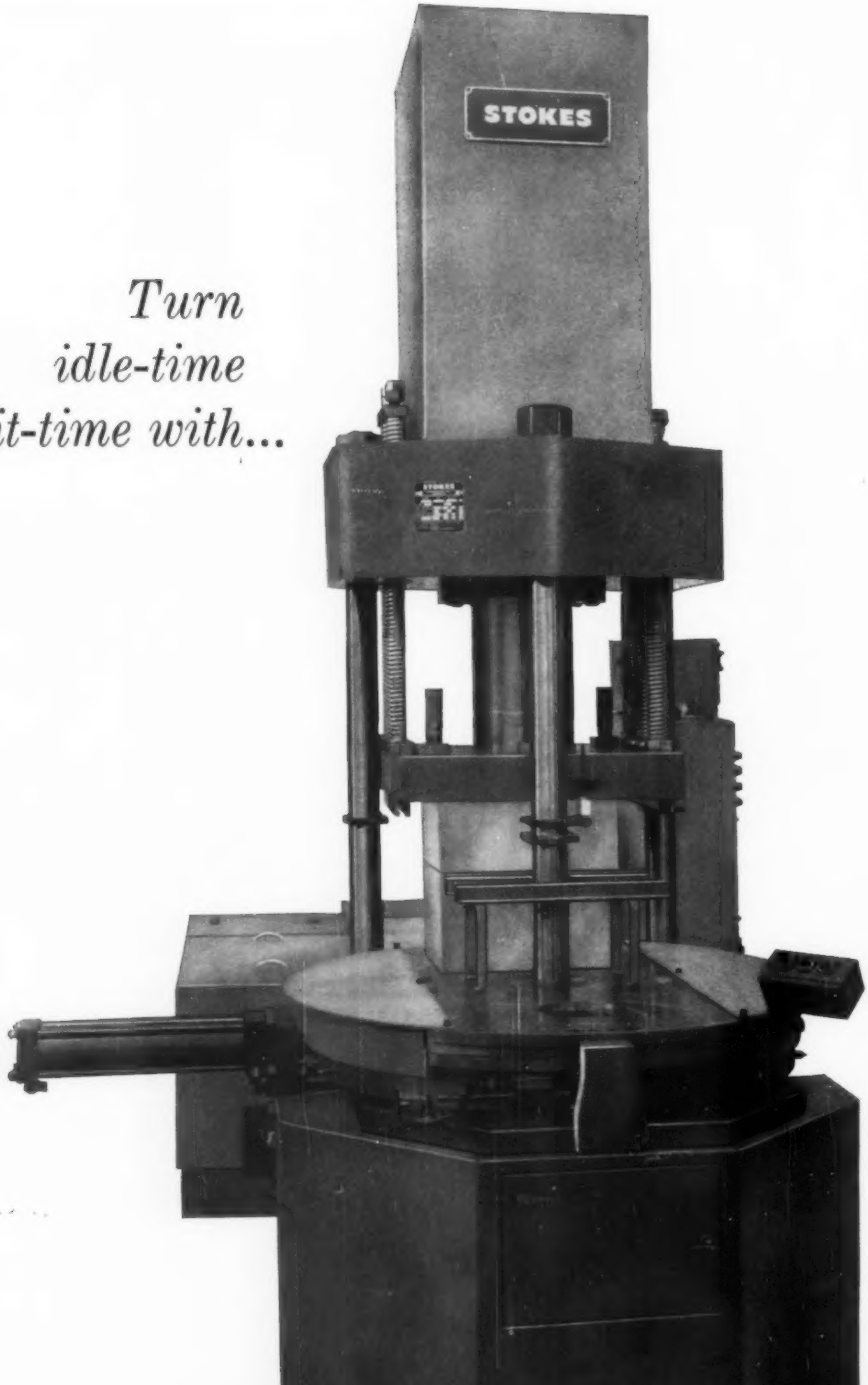
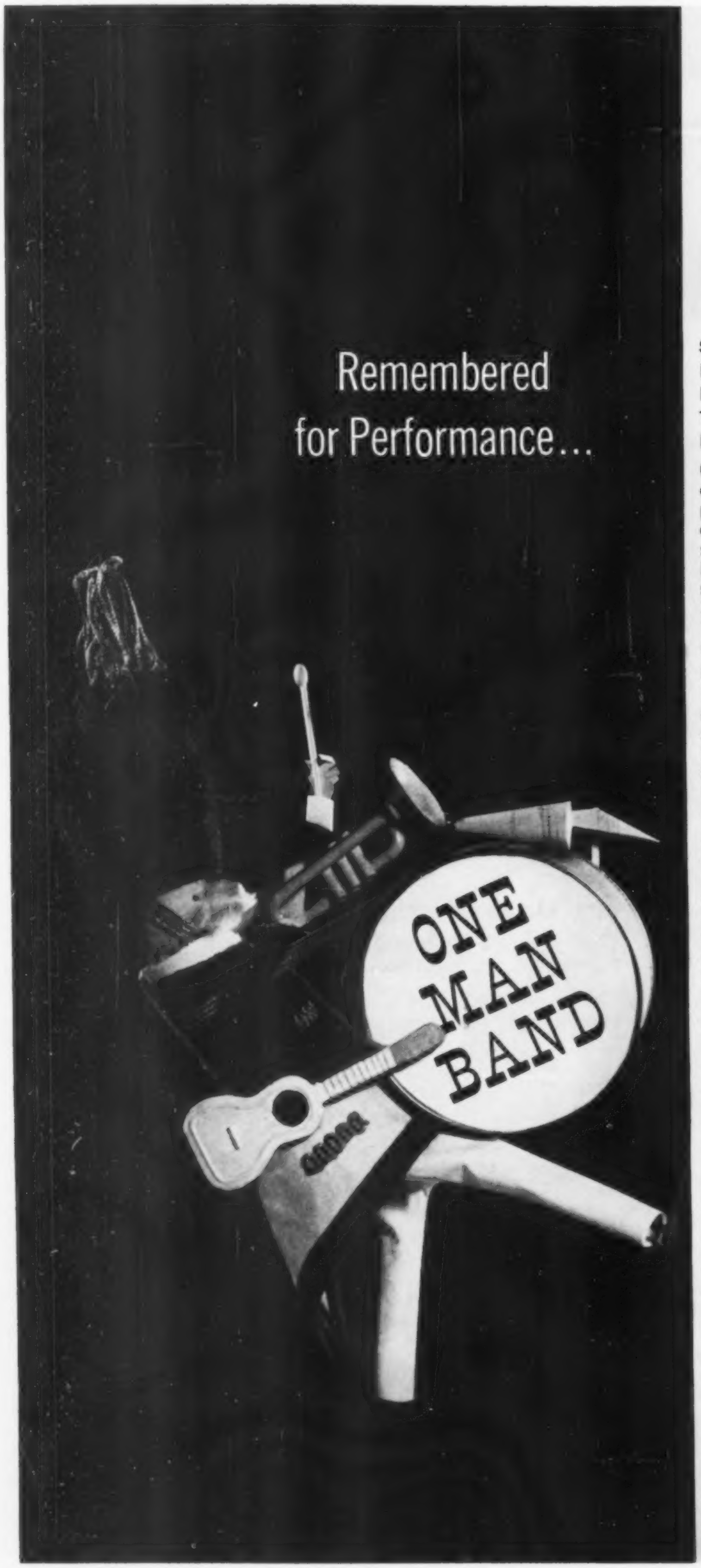


Stokes Model 744, 150-ton insert molding press . . . with moldhalf at ejection station removed.



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CYMEL 592 (asbestos-filled) Additional distinctive properties: resistance to atmospheric extremes; high dielectric strength. Typical applications: connector plugs; terminal blocks; a/c, automotive and heavy duty industrial ignition parts. Specifications: MIL-M-14E MME; Federal L-M-181 Type 2; ASTM D704-55T Type 2, SPI SPEC NO. 27025.

CYMEL 1077 (alpha cellulose-filled) Additional distinctive properties: Surface hardness, heat resistance, unlimited color range. Typical applications: appliance housings, shaver housings, business machine keys. Specifications: MIL-M-14E – Type CMG (in approved colors); Federal L-M-181 Type 1; ASTM D704-55T Type 1, SPI SPEC NO. 30026.

CYMEL 1500 (wood flour-filled) – **CYMEL 1502** (alpha cellulose-filled) Additional distinctive properties: Good insert retention. Typical applications: meter blocks, ignition parts, terminal strips. Specifications: Cymel 1500 (MIL-M-14E Type CMG, Federal L-M-181 Type 6, ASTM D704-55T Type 6); Cymel 1502 (MIL-M-14E Type CMG, Federal L-M-181 Type 7; ASTM D704-55T Type 7.

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Permeability of chlorotrifluoroethylene polymers

By A. W. Myers†, V. Tammela†, V. Stannett†, and M. Szwarc†

The permeability of a number of modifications of chlorotrifluoroethylene polymers to gases (N_2, O_2, and CO_2) and vapors (water and methanol) has been investigated. The effects of crystallinity, plasticization, and copolymerization with vinylidene fluoride are considered.

The transmission of a gas or vapor through a polymer takes place primarily by a diffusion controlled mechanism, wherein the gas dissolves in one surface of the film, passes through by an activated diffusion process, and evaporates from the opposite surface. The rate of permeation through the film per unit area, *q*, may be expressed quantitatively by Fick's first law:

$$q = -D\frac{dc}{dx} \qquad \text{Eq. 1}$$

where the proportionality factor *D* is the diffusion constant and dc/dx is the concentration gradient across the polymer film. Under steady state conditions, and assuming that *D* is not concentration dependent, Equation 1 can be integrated and one obtains:

$$q = \frac{D(c_1 - c_2)}{t} \qquad \text{Eq. 2}$$

where *t* is film thickness and c_1 and c_2 are the concentrations at the high and low pressure surfaces, respectively. Applying Henry's law, one obtains:

$$q = \frac{DS(p_1 - p_2)}{t} \qquad \text{Eq. 3}$$

where *S* is the solubility of a gas in cc./cc. of polymer at a pressure of 1 cm. Hg with the volume of gas corrected to S.T.P., and p_1 and p_2 are the pressures of the gas at the high pressure and low pressure surfaces, respectively.

P, the permeability constant, is defined as cc. of gas at S.T.P. permeating per second through a film of 1 cm.^{2} area and 1 mm. thickness under a pressure difference of 1 cm. Hg and may be expressed as:

$$P = DS = \frac{tq}{p_1 - p_2} \qquad \text{Eq. 4}$$

P is independent of thickness and pressure for gases. For vapors, it may increase with pressure. The temperature dependence of *P* may be expressed as an Arrhenius relationship, as follows:

$$P = P_o \exp.(-E_p/RT) \qquad \text{Eq. 5}$$

where E_p is the activation energy and P_o is the pre-exponential factor associated with the overall permeation process.

Method

The experimental method used to measure *P* was similar to that described by Barrer (1).[1] The

[1] Numbers in parentheses link to references at the end of article, p. 211.

*Reg. U. S. Pat. Off.

†Chemistry Dept., State University College of Forestry at Syracuse University, Syracuse, N. Y.

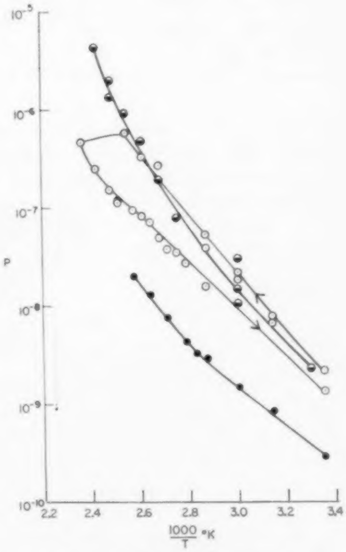

FIG. 1: Permeability of Kel-F films to water vapor (about 20 mm. Hg pressure). Legend: ◒—Kel-F 300 P25 (plasticized homopolymer); ⊙—Kel-F 500 (copolymer containing 3% vinylidene fluoride); ●—Kel-F 300 (quenched low-crystallinity homopolymer).

Table I: Permeability of amorphous and crystalline polychlorotrifluoroethylene[a]

Gas	Temp., °C.	P, 10^{-10} cc./mm./cm.²/sec./cm. Hg Amorphous	Crystalline
N_2	25	0.05	0.03
	40	0.20	0.09
	50	0.35	0.12
	60	0.63	—
	75	—	0.51
O_2	0	0.07	—
	25	0.40	—
	40	0.92	0.25
	50	1.44	0.43
	60	—	0.68
	75	5.74	—
	80	—	1.85
CO_2	40	2.11	0.48
	50	—	0.89
	60	6.12	1.37
	80	18.5	3.67

[a] Unplasticized Kel-F 300 films of about 30 and 80% crystallinity, respectively.

Table II: Permeability of extruded films versus crystalline and amorphous films of unplasticized Kel-F 300

Film	P, 10^{-10} cc./mm./cm.²/sec./cm. Hg N_2 (50° C.)	N_2 (75° C.)	CO_2 (75° C.)
Extruded 2 mil	0.18	0.86	5.8
Extruded 5 mil	—	0.94	6.15
Molded and annealed (~80% crystalline)	0.12	0.51	3.0
Molded and quenched (30% crystalline)	0.35	1.8	14.5

Table III: Temperature dependence of the permeability constant for chlorotrifluoroethylene polymer and copolymers

Film[a]	Gas	P_o	E_p kcal./mole
Amorphous polymer	N_2	0.20	14.3
" "	O_2	0.0058	11.2
" "	CO_2	0.033	11.8
Crystalline polymer	N_2	0.0014	11.9
" "	O_2	0.00093	10.9
" "	CO_2	0.0027	11.1
Copolymer X-500 (3)	N_2	0.085	13.6
" "	O_2	0.40	13.8
" "	CO_2	0.31	13.1
" X-800 (25)	N_2	6.75	15.5
" "	CO_2	24.1	15.1
" X-3700 (70)	N_2	1.55	13.5
" "	O_2	1.25	12.8
" "	CO_2	1.30	11.9
" X-5500 (50)	O_2	3.7	13.1
" "	CO_2	60	13.9

[a] The figures in parentheses are the percent of vinylidene fluoride in the copolymer.

apparatus consists essentially of three parts: 1) a source of high vacuum, 2) a constant pressure source of gas or vapor under study, and 3) a diffusion cell containing the polymer film.

The film is first placed into the diffusion cell and sealed with a mercury seal. The cell is then attached to the high vacuum apparatus and the whole diffusion cell and adjoining parts are thoroughly degassed. Gas or vapor at a known pressure is then admitted to one side of the film and the gas permeates at essentially a constant pressure through the film into a receiving section where the increase in pressure with time may be recorded by a McLeod gage. When the slope of the pressure-versus-time curve remains a constant, the steady state has been reached and *P* may be readily calculated. Details of the equipment have been described in a number of recent publications (2,3), which should be referred to for further information.

Effect of crystallinity

Chlorotrifluoroethylene polymers may be modified in various ways, including varying the degree of crystallinity, plasticization, and copolymerization.

The effect of crystallinity was studied by preparing two samples by compression molding. One sample was quenched and was mainly amorphous; the other was carefully annealed to give a more highly crystalline film. The crystallinity of the quenched specimen was estimated to be about 30% and that of the annealed to be 80 percent. The permeability values were measured and are tabulated in Table I, above, where it can be readily seen that a sharp reduction in the permeability constant results from crystallization of the material.

This same behavior has been found with other polymers, such as polyethylene. Undoubtedly, the main contribution to the gas permeation comes from the amorphous regions, with the crystalline regions generally being impermeable. Thus, increasing the crystallinity from about 30 to 80% reduces the permeability constant to almost one-third of the original value, or approxi-

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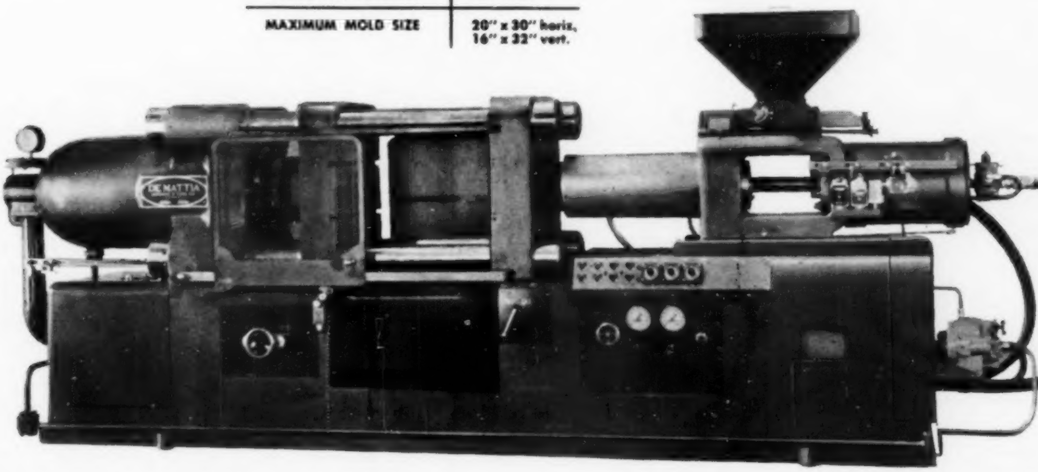

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Table IV: Effect of plasticizer on permeability of polychlorotrifluoroethylene

Gas	Temp., °C.	P, 10^{-10} cc./mm./cm.²/sec./cm. Hg Unplasticized	Plasticized[a]
N_2	50	0.18	5.5
	75	0.86	25.7
O_2	0	0.04	1.1
	30	0.52	5.6
	60	2.90	28.0
CO_2	50	3.7	75.0

[a] Plasticizer was low molecular weight polychlorotrifluoroethylene.

Table V: Permeability of chlorotrifluoroethylene copolymers[a]

		P, 10^{-10} cc./mm./cm.²/sec./cm. Hg			
Gas	Temp., °C.	X-500 (3)	X-800 (25)	X-5500 (50)	X-3700 (70)
N_2	0	—	0.029	—	0.25
	12.5	—	—	—	—
	25	0.11	0.30	—	1.62
	50	0.52	2.34	—	12.7
	75	2.92	13.1	—	56.2
O_2	0	—	—	1.11	0.62
	12.5	—	—	3.74	—
	25	0.20	—	9.34	5.46
	40	1.18	—	—	—
	50	2.05	—	50.5	34.1
	75	7.73	—	—	111
CO_2	0	0.10	0.19	—	2.73
	25	0.80	1.83	39.8	27.2
	50	5.25	15.2	248	137
	75	19.5	70.8	—	440

[a] The figures in parentheses are the percent of vinylidene fluoride in the copolymer.

Table VI: Permeability of polychlorotrifluoroethylene to water and methanol vapors (amorphous unplasticized Kel-F 300)

Vapor	Temp., °C.	P, 10^{-9} cc./mm./cm.²/sec./cm. Hg
Water (~20.5 mm. pressure)	25	0.29
	45	0.85
	60	1.5
	75	2.8
	80	3.3
	85	4.3
	95	7.6
	105	13.0
	115	20.0
Methanol (~50 mm. pressure)	60	0.81
	67	1.4
	75	2.4
	85	5.1
	95	8.7
	105	9.1
	115	9.4
Permeability recorded after a run at 115° C.	67	0.62

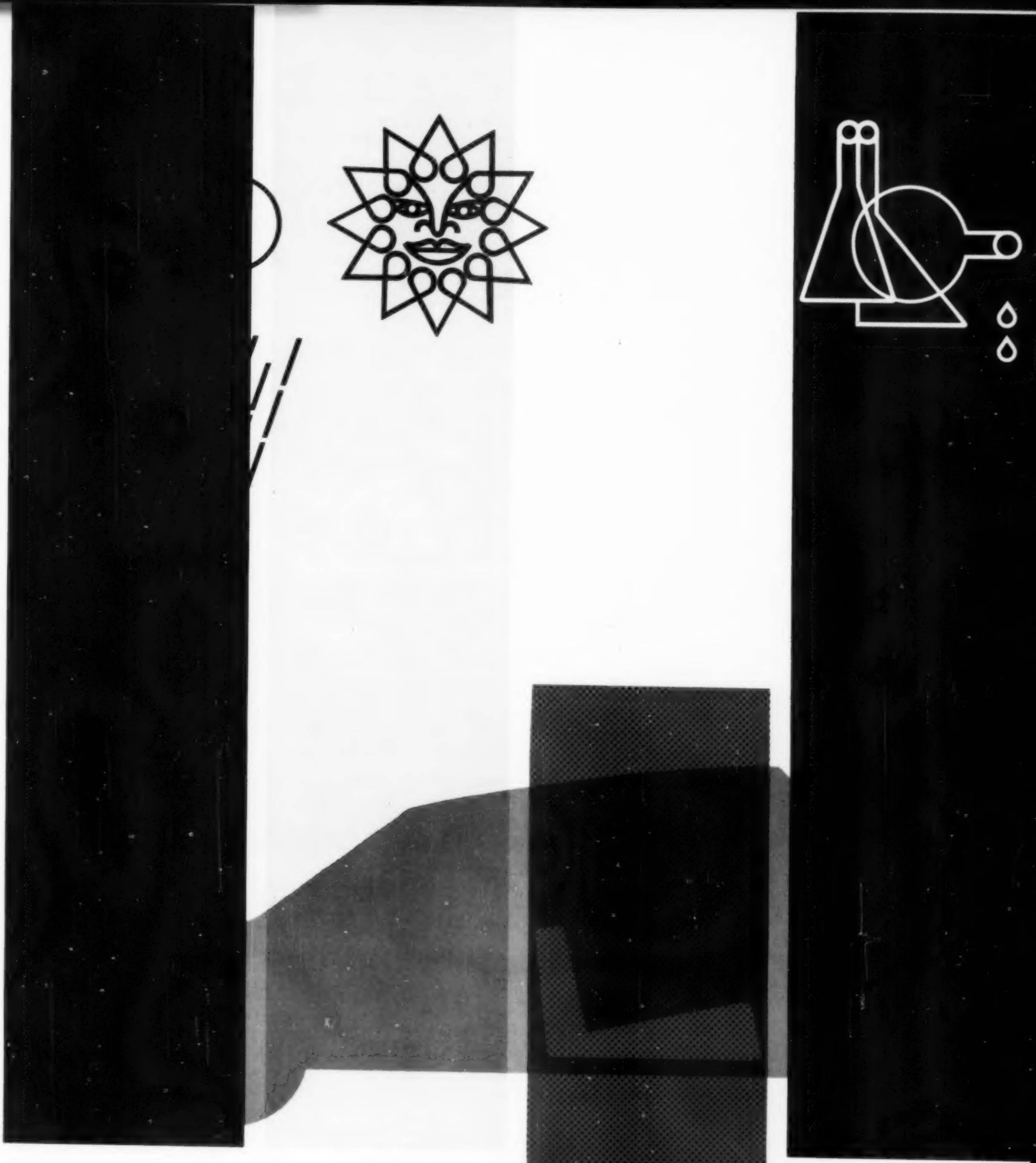
mately in line with the decrease in the amorphous content. A more complete discussion on the effect of crystallinity on gas and vapor permeability is given in References 4 and 5.

The degree of crystallinity and the gas permeability of commercial films will depend on the heat treatment accorded them in processing. Values for two typical extruded films are shown in Table II, p. 140, compared with the corresponding values for the quenched and annealed films. It can be seen that intermediate values are obtained but closer to the values obtained with the more highly crystalline film.

The temperature dependence of the permeability constant for N_2, O_2, and CO_2 transmission through polychlorotrifluoroethylene polymers is shown in Table III, p. 140. There is little change in solubility with "real" gases at the temperature range investigated; the main contribution to the activation energy of permeation is the activation energy of diffusion. The activation energy for diffusion may be thought of as the energy needed to separate the polymer molecules sufficiently to allow the gas molecule to move between and is principally a result of thermal motion of the polymer molecules. Thus, activation energies for diffusion can be classed according to the molecular diameter (6). It can be seen from experimental data that oxygen (molecular diameter 2.98 A.) has a lower energy of permeation than nitrogen (molecular diameter 3.18 A.) for the same material. The activation energy for diffusion also increases with, for example, increasing cohesive energy of the polymer and, therefore, diffusion rates will be dependent on the polymer. The high polarity and cohesive energy of Kel-F films results in high energies of permeation. A further discussion of the temperature dependence is given in the copolymers section.

Effect of plasticization

The effect of plasticizer on the permeability constant of polychlorotrifluoroethylene polymers is shown in Table IV, above, where it can be seen that the plasticized film is many times more perme-



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able than the unplasticized. The permeabilities of plasticized and unplasticized Kel-F[2] films to hydrogen and carbon dioxide at a number of temperatures have been reported by Brubaker and Kammermeyer (7). Similar large increases in the permeability constants with plasticization were found. In an earlier publication (8), the permeability constants of Trithene[3] B for various gases and temperatures were reported. We want to clearly point out that those results were for the plasticized film and thus gave understandably higher results compared to the unplasticized film as shown in Table IV. Undoubtedly, the increase in permeability for the plasticized film is mainly due to an increase in the diffusion constant. The solubility of permanent gases is not believed to be greatly affected by plasticization. The plasticizer reduces the cohesive forces giving rise to easier penetration by the diffusing species. This is reflected in both the larger diffusion constant and the lower energy of activation for the overall permeation process. A further discussion on the effects of plasticizers on gas and vapor permeability may be found in References 2 and 9.

[2] Trademark of Minnesota Mining & Mfg. Co.
[3] Trademark of Visking Co., div. of Union Carbide Corp.

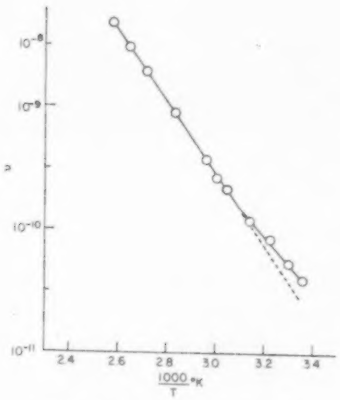


FIG. 2: Permeability of Kel-F 300 (quenched low-crystallinity homopolymer) to carbon dioxide.

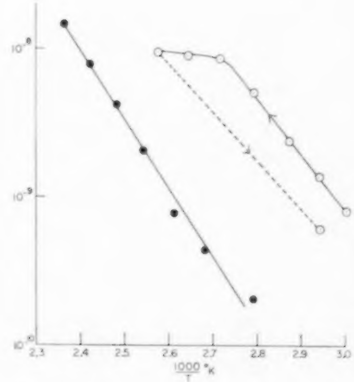


FIG. 3: Permeability of Kel-F films to methanol. Legend: ⊙—Kel-F 300, quenched (50 mm. Hg methanol pressure); ●—Kel-F 500 (100 mm. Hg methanol pressure).

Copolymerization

A series of chlorotrifluoroethylene copolymer films were prepared and their permeabilities measured. These results and the approximate composition of the copolymers are shown in Table V, p. 142.

All the copolymers have higher gas permeability constants than even the amorphous homopolymer. This would be anticipated, since copolymerization provides internal plasticization allowing easier diffusion of the penetrant gas or vapor. Furthermore, the solubility will increase as the crystallinity decreases due to copolymerization. As the percentage of the copolymer is increased beyond about 50%, the permeability constant begins to decrease again. This type of behavior is characteristic of a range of copolymers, although complicated in this case since both monomers alone lead to crystalline polymers.

The temperature dependencies of the various copolymers, together with those found for amorphous and crystalline polychlorotrifluoroethylene, are given for the permanent gases in Table III. No clear pattern in the values can be seen in the activation energies, although somewhat larger values are obtained with the copolymer. It should be pointed out, however, that with highly impermeable films such as these, the experimental error is enough to mask the expected differences in the activation energies. Differences in the pre-exponential factors are more striking and reflect, to some extent, the openness of the polymer structure. Thus, P_0 values for the amorphous homopolymer are more than 100 times those of the crystalline sample. Increasing copolymerization first increases P_0 and then begins to decrease it, presumably towards the value of the homopolymer of the co-monomer.

Water and methanol permeabilities

The permeabilities of a number of Kel-F polymers to water vapor are shown in Table VI, p. 142. The method used for measuring these values has been **(To page 211)**

Table VII: Permeability of plastics films to water vapor (25° C.) and to gases (30° C.)

Material	*P, 10^{-10} cc./cm.²/sec./mm./cm. Hg* H_2O	N_2	O_2	CO_2
Kel-F 300 (unplasticized)	<2.9[a]	0.03	0.10	0.72
Saran	10.0	0.0094	0.053	0.29
Polyethylene terephthalate (Mylar A)	1,300	0.05	0.22	1.53
Rubber hydrochloride, unplasticized (Pliofilm NO)	260	0.08	0.30	1.7
Nylon 6	1,770	0.10	0.38	1.6
Polyvinyl chloride (unplasticized)	1,560	0.4	1.2	10
Polyethylene (0.953 density)	160	3.3	11.0	43
Butyl rubber	—	3.1	13.0	52
Cellulose acetate (plasticized)	68,000	2.8	7.0	68
Polyethylene (0.938 density)	298	6.6	21	74
Polystyrene	12,000	2.9	11	88
Rubber hydrochloride, plasticized (Pliofilm P-4)	—	6.2	24	182
Polyethylene (0.922 density)	1,000	22	69	280

[a] On quenched low-crystallinity sample, lower values are obtained with annealed films.

HERCULES

Plastics Hi-Lites

Vol. II, No. 3

New Housing Projects, 1960 Style

Product builders achieve significant improvements with Pro-fax® polypropylene

BULLETIN

WASHINGTON, D. C. . . . The Food & Drug Administration has issued a formal regulation, appearing in the Federal Register, authorizing the use of Pro-fax polypropylene in products coming in direct contact with all kinds of food. Pro-fax thus becomes the first packaging material to win approval through the issuance of a formal Food Additives regulation. Author of the successful petition was Hercules Powder Company. Hercules predicts widespread use of Pro-fax in food uses, including packaging films, molded containers, coatings, liners and dispensers used in food handling.

Plastic housings in all manner of sizes and shapes, used in an across-the-board list of products, are among the first big developments of the '60s . . . an exciting clue to things ahead. Materials such as Pro-fax polypropylene are fast changing the face and function of many a product, lending new color and styling appeal, improved performance, and above all—*lower cost!*

Measured by yesterday's standards the achievements of today's new materials border on the impossible: they provide high resistance to heat, moisture, household chemicals, foods and cosmetics. They offer rich color and are ideally adapted to the attractive styling requisite for modern merchandising. Yet because they are low-cost materials, adaptable to rapid cycle injection-molding, they are *priced right!*

No wonder that just about every new plastic housing project you see these days is a Pro-fax project. Here are a few of the latest.

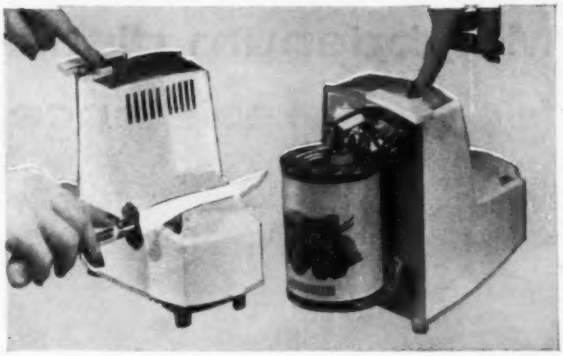
AROUND THE YARD

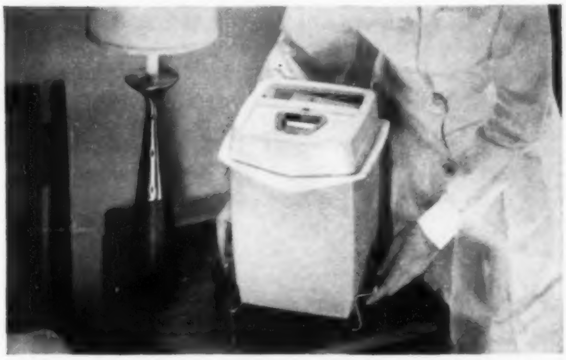
A handsome Pro-fax housing is the new symbol of quality on today's modern power mower. An excellent example is this high-styled motor shroud for the 1960 Power-Matic. Its beauty belies its rugged strength, for this sturdy housing is virtually unbreakable and will permanently resist heat, moisture, gasoline, oils and greases. Molded-in mountings eliminate the need for metal parts in the assembly, providing a design that is completely corrosion-proof. In addition to the Power-Matic shroud, Amos Molded Plastics, Edinburg, Indiana, has designed, developed and produced a series of similarly well-engineered Pro-fax mower housings for Power Equipment, Cicero, Indiana, and its value-conscious customers.

IN THE KITCHEN

Pro-fax in the kitchen spells new convenience and satisfaction for homemakers. Knapp-Monarch's Redi-Matic automatic can opener-knife sharpener features a gleaming white Pro-fax housing, and as a result is impervious to damage from staining and rough handling. The Redi-Matic automatically opens cans of all shapes, and sharpens knives of all sizes. Thanks to Pro-fax, it's a luxury styled unit designed to blend beautifully with any kitchen decor.

Molded by: Warren Molded Plastics, Cortland, Ohio.





ABOUT THE HOUSE

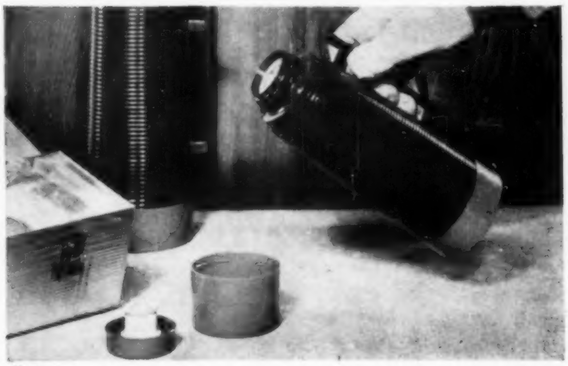
Fast becoming standard home accessories, vaporizers and humidifiers have gotten a big boost in appearance and function by the use of Pro-fax. The new Northern automatic vaporizer/humidifier (shown here) features a bowl and lid molded with Pro-fax, in contrasting colors, which combine in a compact, easy-to-carry appliance that is both useful and attractive wherever it serves in the house.

Pro-fax bowl and lid molded by Cruver Manufacturing Company, Chicago, Illinois.

IN THE NURSERY

Modern style and top performance go hand in hand in Formulette's bottle warmer. It's molded with Pro-fax, of course, for a luxury finish plus resistance to heat and moisture, in a rigid, thin-walled, lightweight unit that is easy to handle, always safe and the ultimate in completely sanitary nursery equipment.

Molded by Boonton Molding Company, Boonton, New Jersey, for Formulette Company, Inc., Jamaica, New York.



IN THE LUNCH BOX

Breadwinners, too, enjoy the convenience and luxury of Pro-fax. The handle, jacket, and collar of Aladdin's new Dura-Clad vacuum bottle, with its unique "Pitcher-Pour" handle, are all molded in one piece with Pro-fax. Pint-size (shown here in use) fits all workmen's lunch kits while the quart size (appearing in the background) is designed to fit conventional outing kits. Both models are heat-, scratch-, and stain-proof.

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CP60-9 THREE NEW MATERIALS FOR THE PLASTIC INDUSTRY

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Molybdenum disulfide in nylon for wear resistance

By Thomas E. Powers*

Designers and molders alike are finding that nylon plastic containing controlled amounts of molybdenum disulfide homogeneously dispersed is capable of producing parts having superior wear resistance at lower costs. Injection molded parts have better wear and abrasion resistance, lower coefficients of friction, and better dimensional stability than parts made of conventional nylon. Molders report faster molding cycles, less shrinkage and distortion, easier ejection, and reduced mold lubrication, all of which tend to cut molding costs.

The addition of precise amounts of molybdenum disulfide to nylon improves a wide range of characteristics which, in combination, add up to decidedly superior performance and extend the usefulness of industrial plastic components. The improvement is not unexpected since molybdenum disulfide (MoS_2 or moly-sulfide) has been shown by tests to be one of the best solid lubricants. According to figures from press fit tests, natural MoS_2 has a kinetic coefficient of friction one-third that of the next best lubricant.

Design advantages

Design men are interested, naturally, in the end results of the addition of molybdenum-disulfide to nylon. One of the best ways to indicate these results is by comparison with conventional type 6/6 nylon. Physical properties of the MoS_2-nylon combination, called Nylatron[1] GS, are listed in Table I, p. 150, and comparative wear rates are illustrated in Fig. 1, right. These improved key properties produce some outstanding results when translated into actual part design.

Greater wear. Gears, wear strips, and bearings have outworn standard nylon parts by 2 to 1. The test data in Fig. 1 show that the wear rate for the GS-nylon is approximately half that of nylon-6/6. For example, in nonlubricated thrust bearing shoe parts used in motor stairs equipment, GS-nylon outwore standard nylon over 3 to 1, while drive gears molded of GS-nylon for household portable mixers increased the wear life of the gears between 70 and 100 per cent.

The abrasion resistance of nylon-6/6 is well known and applications utilizing the material under wear conditions are numerous. The GS-nylon exhibits even superior abrasion resistance and wear characteristics. As a dry bearing, it can be used at PV (pressure-velocity) ratings as much as 50% higher than nylon-6/6 because nylon with molybdenum disulfide runs cooler, smoother, and quieter with less friction to generate heat; maintains established fits and running clearances over a greater temperature range; and is harder and stiffer than ordinary nylon.

GS-nylon parts can often replace metal components where high wear is a problem. In one instance, metallic actuating levers, cams, and bearing blocks used in a 500-v., 150-amp. switch had to be replaced after only 500,000 to 600,000 cycles. Since GS-nylon has been used, test switches have been cycled more than 18,000,000 times without a failure.

Dimensional stability. Many applications for mechanical and electrical wear parts require extremely close tolerances and a high degree of dimensional stability. One such part is the "card pusher" slide used in a new IBM 88 punched card collator. (Fig. 2, p. 153). Fabricated nylon-6/6 was used for this part in the development period, but it was necessary to lubricate the long 5-in. tracks. Use of lubricant caused dust accumulation and consequent poor operation of the slides. No surface lubricant is now necessary with GS-nylon. Dimensional stability is essential and the part exhibits no warpage despite the range in wall thickness from ⅛ to $^9/_{16}$ inch.

Shrinkage and warpage are tied so closely to internal stress that it is necessary to consider their combined influence. Nylon with MoS_2 shrinks less and more uniformly than conventional nylon in any given section. Its coefficient of linear thermal expansion (as shown in Table I) is approximately 40% less. This provides better size control as well as more accurate molding tolerances.

Coupled with reduced shrinkage is a marked reduction in internal stresses. All molded parts have some built-in stress, but

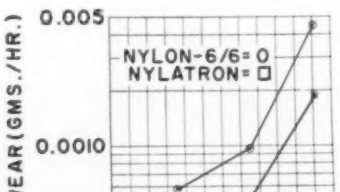


FIG. 1: Accelerated wear tests made to indicate relative rates of wear between moly-filled and unfilled nylon. Both specimens were run against steel cleaned with carbon tetrachloride. Rubbing velocity 1165 revolutions per minute. (160 linear ft./min.). Surfaces were not lubricated.

* Molding Resins Div., The Polymer Corp., Reading, Pa.
[1] Trademark of The Polymer Corp.

GS-nylon parts have decidedly lower stress due to their high degree of crystallinity. The different chracteristics exhibited by the amorphous layer and the more crystalline body of a standard nylon molded part are a prime source of internal stress. The lack of uniformity in the structure of these layers and/or a predominance of the amorphous layer imparts a high degree of stress to the molding. The result is nonuniform shrinkage or *warpage*.

In heavy sections, most of the volume of the material has a crystalline make-up; therefore, it is the properties of this crystalline make-up that predominate. As thinner sections are molded, the outer layers of amorphous structure constitute a greater percentage of the entire part, and dimensional change (warpage) produced by internal stresses after the molding operation are more pronounced.

The results of tests on a thin disk (Fig. 3, p. 153) molded under the conditions reported in Table II, below, illustrate the decreased shrinkage and warpage obtained with the GS-nylon. Measurements were taken from the peak in the curvature of each disk to the surface of a flat plate. As indicated by the dimensions, the disk is designed with a slight curvature. Ordinary nylon measured 0.557 in., whereas GS-nylon measured 0.217 inch. Thus, from the nominal dimension of 5/32 in., the regular nylon warped more than six times as much.

The other major factor influencing dimensional stability is moisture absorption. As with other nylons, GS-nylon picks up moisture until equilibrium condition are reached. This will result in an increase in the part size, but the new composition absorbs 25% less moisture than nylon-6/6. This is important for parts such as submerged pump impellers (as shown in Fig. 4, p. 154).

These impellers, molded of nylon containing moly-disulfide, are more efficient, last longer, and are less expensive than impellers made from either ordinary nylon or brass. Impeller efficiency is higher due to improved smoothness of the water passages. The part in operation is completely submerged, but there is no prob-

Table I: Comparison of physical properties of Nylatron GS and nylon-6/6

Property[a]	*ASTM Method*	*Nylatron GS*	*Nylon-6/6*
Tensile strength at 73° F., p.s.i.	D638-52T	12,300	11,800
Modulus of elasticity at 73° F., p.s.i.	D638-52T	575,000	400,000
Flexural strength at 73° F., p.s.i.	D790-49T	18,000	13,800
Izod impact strength at 73° F., ft.-lb./in. of notch	D256-54T	0.62	0.94
Heat distortion temp., 264 p.s.i. load, °F.	D648-45T	325	200
Coefficient of linear expansion, in./in./°F.	D696-44T	3.5×10^{-5}	5.5×10^{-5}
Dielectric strength (short-time), v./mil	D149-55T	356	385
Specific gravity	D797-48T	1.16	1.14
Water absorption[b]	D570-42		
24 hr., %		0.80	1.10
48 hr., %		1.14	1.48
Flammability, in./min.	D635-44	Self-extinguishing	Self-extinguishing
Color		Gray to black metallic	Buff white
Tensile impact[c], ft.-lb./sq. in.	——	118	137
Deformation under load, %	D621-51	0.8	1.0
Brittleness temperature, °C.	D746-55T	−15	−30
Kinetic coefficient of friction versus steel	——	0.16 to 0.2	0.2 to 0.3

[a] The values given are average values and should not be used for specification purposes. The data for Nylatron GS were obtained using annealed test specimens.
[b] Specimens were ½ in. in diameter and ⅛ in. thick.
[c] C. G. Bragaw, Modern Plastics 33, 199-203, 206 (June 1956).

Table II: Comparative molding conditions and shrinkage (in inch per inch) for parts molded of nylon-6/6 and Nylatron GS

Part and material	*Injection temperature* Rear °F.	Front °F.	Nozzle °F.	*Injection cycle* Plunger sec.	Die close sec.	Unloading time sec.	*Injection pressure* p.s.i.	*Shrinkage* in./in.
Disk (Fig. 3)								
Nylon 6/6	675	610	615	11	12	5	1000	0.021
Nylatron GS	690	630	635	10	8	4	1000	0.007
Flare nut (Fig. 5)								
Nylon 6/6	570	515	535	5	5	0	1000	0.011
Nylatron GS	570	545	550	5	3	0	1000	0.006
Bearing block (Fig. 6)								
Nylon 6/6	600	550	560	10	6	3	800	0.032
Nylatron GS	520	480	490	7	3	3	1000	0.028

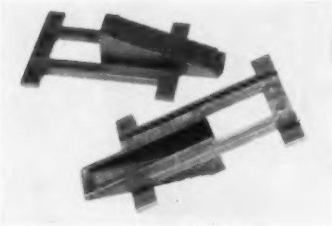


FIG. 2: Extreme dimensional stability is exhibited by this Nylatron GS card pusher slide. The part exhibits no warpage, despite wall thickness variation that ranges from 1/8 to 9/16 inch.

lem of distortion since GS-nylon exhibits less expansion due to moisture absorption than nylon-6/6.

Heat distortion. Advantage was taken of the resistance to heat distortion of moly-disulfide with filled nylon to obtain a 10 to 20% savings by redesign of a Westinghouse oven door assembly. Heat tests conducted on the material showed that it resisted heat much better than standard nylon. GS-nylon resisted distortion at temperatures up to 325° F. under a point-contact 13-lb. load. Wear tests indicated that in this particular application, the parts wore twice as long as ordinary nylon moldings. In typical molded parts MoS_2-nylon composition deforms 20% less under load at room temperature than standard nylons, as shown in Table I.

Other properties. GS-nylon is unaffected by alkalies and most solvents, including hydrocarbons. Electrically, it has excellent insulating properties, a low dielectric constant, and a relatively high dielectric strength. Additionally, the properties of GS-nylon moldings are more nearly equivalent to those of prototypes machined from stock shapes than are ordinary nylon parts; this is a distinct advantage for both part as well as mold design.

Molding advantages

Most of the cost advantages with the moly-disulfide additive come from better molding properties that permit economies in the production of wear parts. These economies are of prime concern to the designer. In general, the improved properties of GS-nylon should be available to designers at no more, and often at less cost than regular nylon parts.

GS-nylon is readily molded on standard injection molding equipment, but mold cycles are commonly faster. The mold cycles (Table II) for the parts illustrated in Figs. 5 and 6, p. 154, are from 20 to 33% faster for GS-nylon than for nylon-6/6. The die closure time is shorter for both parts; the plunger cycle is less for the bearing block.

Less scrap is encountered. The inherent lubricity of molybdenum-disulfide makes it possible to remove the threaded core pins from the flare nuts with very little scrap. Regular nylon seized on the core pins, causing time-consuming interruptions of the cycle for part removal.

Mold lubrication is reduced and frequently eliminated entirely. The bearing block shown in Fig. 6 had a tendency to stick in the stationary half of the mold when conventional nylon was used. This was caused by flashing of material at points where core pins were made to "kiss off" or butt together to form a seal. Because of this sticking, it was necessary to lubricate the mold every few shots. With GS-nylon, however, the flashing has been completely eliminated so that very little lubrication is necessary.

Crystallinity

The advantages of greater wear and lower coefficient of friction are contributed by the lubricating qualities of moly-disulfide. But the contribution of molybdenum disulfide to raising the heat distortion temperature, increasing flexural strength and elastic modulus, and improving dimensional stability comes from an entirely different characteristic, in other words, greater crystallinity.

With ordinary nylon, injection molded parts have relatively low, nonuniform crystallinity. The rapid cooling (quenching) experienced by the molten nylon as it contacts the mold surface produces an almost completely amorphous (noncrystalline) layer or skin. This outer layer does not have optimum bearing qualities and, therefore, it is frequently necessary to lubricate ordinary nylon molded parts.

There is considerable difference in structure between the outer layer and the body of a conventional nylon part. Inherently, the part is less rigid and a high degree of stress is molded into the part.

To demonstrate the reason why GS-nylon has improved properties over ordinary nylon moldings, the extremely thin section disk (Fig. 3) was molded in both GS-nylon and nylon-6/6 materials, using the same equipment. The representative samples used in this test comparison were taken from parts molded with the fastest cycle time of each resin. Approximately eight months after injection molding the disk, several size comparisons were made, along with the photomicrographs (Fig. 7, p. 154) showing the crystalline structure of the parts.

Structure comparisons. In Fig. 7A, the right hand third (the lighter area) of the nylon-6/6 piece is almost entirely amorphous. The middle third has striations of crystallinity (shown as darker streaks) making up 1/3 to 1/2 its area. The left hand third at the base of the sample is essentially all crystalline except for the amorphous edges.

On the other hand, the GS-nylon part (Fig. 7B) displays full crystallinity even to the tip of the disk. The solid gray color of the piece is caused by its very fine, even crystalline structure. The amorphous skin on the GS-nylon part is very thin but, more impor-

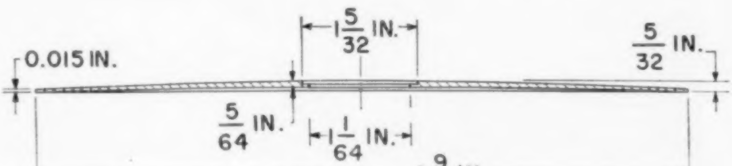


FIG. 3: Dimensions of thin disk used in warpage test.

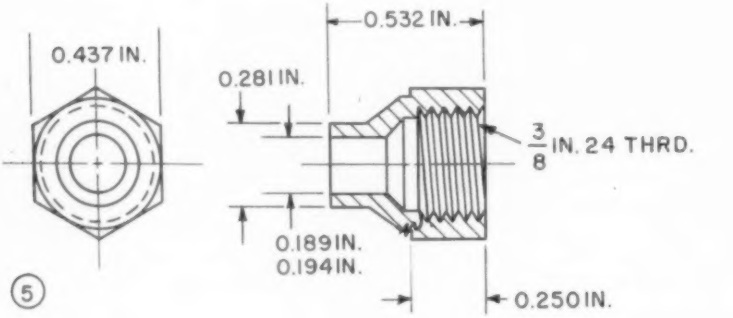
FIG. 4: This two-piece impeller shows the accuracy of parts molded from Nylatron GS. The two parts are sitting lightly together for photographic purposes. At assembly, the two pieces will be pressed together and their mating line on the impeller vein (as shown by arrow) will present a smooth surface.

tantly, it is uniform. Since the part is mostly crystalline, less over-all shrinkage occurs.

Although it was not possible to obtain a strictly quantitative comparison of thickness of the amorphous skin on the two specimens, the GS-nylon had a uniform skin slightly less than 1 mil in thickness, whereas the skin on the nylon-6/6 part varied from 3 to 4 mils in thickness. Standard nylon, therefore, had a 75% greater content of amorphous material with over four times the variability in structure (nonuniformity) compared to GS-nylon. It is important to note at this point that by keeping the amorphous layer at a minimum thickness, the bearing qualities that are contributed by the MoS_2 additives are more fully utilized.

Size comparisons. After over eight months' aging at room temperature, a size comparison shows that the nylon-6/6 part is much thicker, especially at the tip. In this molding, GS-nylon grew far less after molding, resulting in a piece that is both thinner and more uniform. To show this more accurately, 16 equally spaced points around the tapered edge were carefully measured. The mold design included a 1 or 2 mil ridge 5/32 in. back from the edge. The average micrometer readings at the spaced portions on the ridge showed 30 mils for GS-nylon with an 8-mil spread, and 39 mils for nylon-6/6 with a 14-mil spread. Again, in this case, conventional nylon had 30% more hygroscopic expansion and 75% more variation in dimensions than did the GS-nylon. The rate of moisture absorption is, likewise, dependent upon crystallinity.

Generally, crystallinity in nylon promotes practically all of its desirable properties, including the degree of similarity between molded and machined parts. Thus, the improvements in GS-nylon over ordinary nylon exists primarily by virtue of the molybdenum sulfide that is found in the patented formulation.



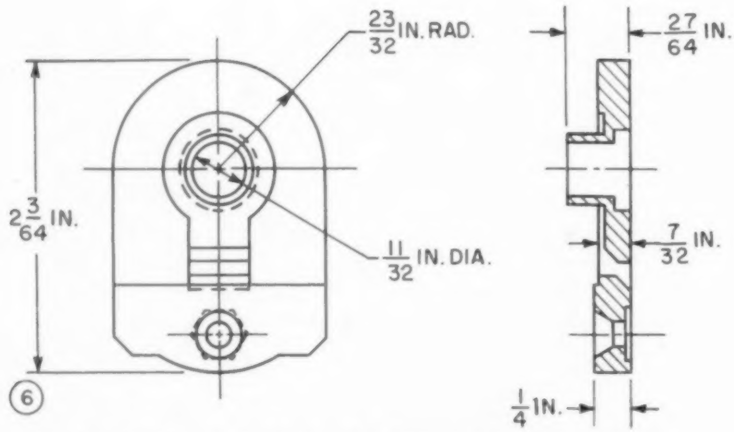


FIG. 5: Dimensions of flare nut used in comparison of molding cycles and shrinkage. **FIG. 6:** Dimensions of bearing block used in comparison of molding cycles and shrinkage.

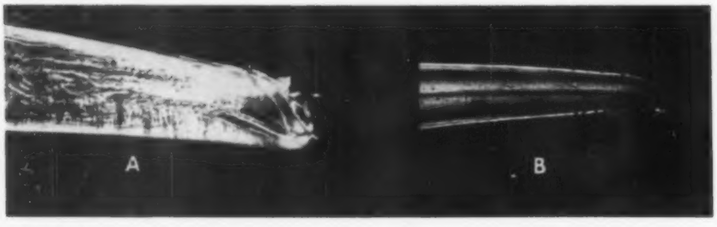


FIG. 7: Microphotographs show the crystalline structure of thin sections molded from nylon-6/6 **(A)** and Nylatron GS **(B)**. Magnification of the sections is 52 times actual size.

Typical wear parts

Many wear parts have been made from GS-nylon, including such applications as gears, bearings, wear pads, thrust washers, cams, door slides, switch components, bearing liners, etc.

Each use of the new product has solved special problems that were encountered with conventional nylon or other materials. Typically, it is used for any wear part that must wear longer and exhibit greater dimensional stability than is possible with the use of ordinary nylon.—**End**

Determination of average cell volume in foamed products

By R. H. Harding*

A method is presented for the measurement of the open cell content and average cell volume of a foamed product. The technique is simple, adaptable to routine operation, and suitable for either quality control or research work. The required apparatus is already available in the laboratories of most of the suppliers. Experience indicates that use of the new approach may well facilitate an improved understanding of foam technology. Factors which have previously been recognized qualitatively may now be studied quantitatively with relative ease.

Rigid and flexible cellular materials are achieving growing importance for application as structural, insulating, cushioning, and buoyant products. In many cases, the suitability of foamed materials for specific uses is a function of the manufacturer's ability to produce an appropriate cell structure. Rigid foams useful as thermal insulators must contain the highest possible percentage of closed cells; these should be small and uniform in size.

In general, the practice in the cellular plastics industry has been to estimate cell sizes either by microscope counting or by direct visual comparison. The former technique has the disadvantage of being too time-consuming for routine application; in addition, only a very small specimen is observed. The latter approach is a qualitative estimate at best: local experience indicates that the observer's opinion is influenced largely by the coarsest structures present. As a result of these drawbacks, the relationships between structure and properties are poorly understood.

Neither of the above methods gives information about the open cell content of a foam. An apparatus that provides such data was recommended by Remington and Pariser in 1957 and is now a widely used tool in the evaluation of cellular plastics[1]. Their method requires only a few minutes to make a measurement; it functions by measuring the volume of air displaced by a foam specimen in a closed chamber. The required equipment is simple, and the only major problem noted is the sensitivity of results to specimen dimensions.

It is generally conceded that additional reliable information concerning the structure of foamed products would prove useful for the progress of modern foam technology. For example, cell size data could be related to manufacturing conditions and to foam properties if they could be made available on a routine basis.

The method described in this paper provides a means for determining the volume fraction of open cells and the average cell volume in a foam. The test is based on the Remington and Pariser (R & P) apparatus, and may require as little as twice the laboratory time of a standard R & P open cell determination. The sensitivity of an R & P result to specimen dimensions is eliminated, and a reliable measure of cell size is, therefore, obtained without recourse to the necessity of microscopic counting.

Derivation of relationship

The observation that the apparent percentage of open cells in a foam is influenced by specimen dimensions provides the basis for the new method. An analysis of the internal geometry of a cellular product leads simultaneously to the explanation for this phenomenon and to the derivation of the quantitative cell volume relationship. The nomenclature and symbols used in the following discussion are presented in the box on p. 160.

Consider first a unit volume of foam. By definition this sample contains N average cells, each of volume V. It is possible that some fraction F of these cells will interconnect in a continuous matrix because of imperfections in the cell walls. In this case only $N(1-F)$ average cells would retain their individual identities.

Let the unit volume of foam be intersected by a plane of unit

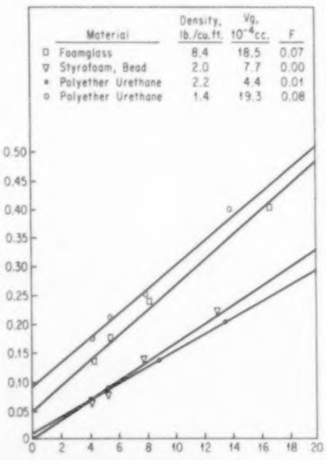


FIG. 1: Actual Oc-R plots obtained for several foamed, rigid materials.

[1]W. J. Remington and R. Pariser, "A new apparatus for determining the cell structure of cellular materials," Contribution 119 of E. I. du Pont de Nemours & Co. Inc., Elastomer Chemicals Dept., presented before the Division of Rubber Chemistry, American Chemical Society, New York, Sept. 12, 1957.

*Research Dept., Union Carbide Chemicals Co.

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area. The number of individual average cells through which this plane passes must be $N^{2/3}$ $(1-F)^{2/3}$. At the same time, since the plane passes through the interconnected maze of open cell units $(NF)^{2/3}$ times, it becomes evident that a perfectly continuous open matrix is not a practical requirement of the method. All of the open cells will be revealed to the hypothetical plane if only a single member of each of the interconnected series of cells is intersected.

The significance of these observations becomes evident when an actual sample of a cellular material is considered immersed in a fluid. The volume of this sample may be Vs units by direct external measurements, but the volume of fluid displaced will be less than Vs in proportion to its penetration into the specimen. A fluid such as air will be able to fill both the cut cells at the specimen surface and the communicating open cells of its interior.

For simplicity, let the foam sample be a rectangular block *H* units high, *T* thick, and *W* wide. Its geometric volume is, of course, Vs = HWT and its nominal surface area is

$$A = 2\,WT + 2\,WH + 2\,HT \quad \text{Eq. 1}$$

The total volume of an average cell is the sum of its associated solid and gas volumes:

$$V = Vp + Vg \quad \text{Eq. 2}$$

The volume exposed to the immersing fluid when a cell is opened is only the Vg component.

The foam specimen contains a total of NVs average cells. The interior volume of the specimen that connects directly to the surface is NFVgVs. When all specimen faces are free of continuous skins, the number $AN^{2/3}$ $(1-F)^{2/3}$ of originally-closed cells within the specimen surface will have been cut open by sample preparation operations. On the average, one half of each cut cell must be retained by the sample; the gas volume exposed by cutting operations is, therefore, $AN^{2/3}$ $(1\text{-}F)^{2/3}$ Vg/2.

The volume of gas displaced by a foam specimen is the geometric volume, less the volume of the specimen's surface-connected open cells, less the volume of cells in the specimen's cut surface; mathematically, it is

$$Vd = Vs - NFVg\,Vs - AN^{2/3}(1-F)^{2/3}\,Vg/2 \quad \text{Eq. 3}$$

The apparent open cell volume indicated by gas displacement is

$$Vo = Vs - Vd = NFVg\,Vs + AN^{2/3}(1-F)^{2/3}\,Vg/2 \quad \text{Eq. 4}$$

The indicated volume fraction of open cells is

$$Oc = Vo/Vs = NFVg + AN^{2/3}(1-F)^{2/3}\,Vg/2\,Vs \quad \text{Eq. 5a}$$

Defining *R* as the geometric surface area-to-volume ratio, A/Vs,

$$Oc = NFVg + N^{2/3}(1-F)^{2/3}\,RVg/2 \quad \text{Eq. 5b}$$

Equation 5 represents a straight line function of Oc in terms of *R*, and may be solved for the Vg and *F* of any foamed product containing an appreciable percentage of closed cells. The only experimental requirement is that the only cell content of a sample be determined at a minimum of two known *R* levels.

A more convenient form of Eq. 5 may be derived for actual usage. It provides an advantage by revealing the influence of foam density on the apparent Oc of a sample at any *R*.

The density, Df, of any foam sample must equal that of an average cell. From a material balance based on Eq. 2, it is evident that

$$(Df)\,V = Dp\,Vp + Dg\,Vg \quad \text{Eq. 6a}$$

If it can be assumed that the density of the gas contained within the closed foam cells is nearly equal to that of the surrounding air, then its effective density, Dg, is zero. Eqs. 6a and 2 rearrange to

$$Vg = V\left(1 - \frac{Df}{Dp}\right) \quad \text{Eq. 6b}$$

By substitution of Eq. 6b in 5b, and upon recognition of the fact that *N* must equal 1/V, the preferred solution is found to be

$$Oc = F\left(1 - \frac{Df}{Dp}\right) + \frac{R\,Vg^{1/3}}{2}(1-F)^{2/3}\left(1 - \frac{Df}{Dp}\right)^{2/3} \quad \text{Eq. 7}$$

Naturally, the dimensional units employed must be consistent. In local work the experimental data are obtained in the English system, but are converted to the metric system for convenience in reporting Vg.

Experimental procedure

The apparatus, technique, and preliminary calculations required for the cell volume determination are those described by Remington and Pariser.[1] They are reviewed briefly in the following two paragraphs. It is suggested that the

Table I: Comparison of cell volume averages by gas displacement (Vg) with microscopic estimates

Foam sample	*Average cell volume, 10^{-4} cc.* — *Microscope*[a]	*Displacement*	*Deviation*
1	15.9	23.7	−7.8
2	7.7	4.6	+3.1
3	9.0	8.4	+0.6
4	12.3	11.4	+0.9
5	13.8	10.1	+3.7
		Average =	+0.1

[a] Each microscopic value was calculated from averaged measurements of the apparent height and width of about 50 individual cells.

Table II: Effect of specimen dimensions on apparent open cell content

Foam sample	*Experimental Oc at the indicated R level* — *R = O*	*R = 4 in.*$^{-1}$	*R = 8 in.*$^{-1}$
1	0.042	0.146	0.250
2	0.100	0.153	0.206
3	0.022	0.098	0.175
4	0.010	0.081	0.152
5	0.022	0.084	0.146

reader consult the original paper for full details.

Essentially the R & P method measured Vd, the volume of air displaced by a foam specimen in a closed chamber. This volume represents the space occupied by the closed cells plus the cell walls in the specimen. Subtracting Vd from the geometric specimen volume, Vs, gives the volume of open cells in the specimen, Vo. The foam weight, divided by the specific gravity of the solid of which it is composed, provides the volume of cell walls. The volume percentages of open and closed cells, and of foam solids, are now calculated for the specimen.

Volumes are measured in an apparatus containing two calibrated, sealed chambers separated by a manometer. One of these encloses the specimen with some residual volume of air. The reference chamber contains a known volume of air, adjustable with a mercury-filled burette, at the same temperature and pressure. A slight vacuum is imposed on both systems when the volume of each is increased by equal increments. The actual volume of air displaced by the specimen is shown by R & P to be available when this operation produces no pressure differential between the chambers. A few trials normally suffice to leave the manometer balanced both before and after the vacuum is drawn.

Specimens: In the new cell volume method, at least two such R & P readings of Vd are required for each determination. Local experience indicates that four readings per specimen, each at a different geometric surface-to-volume ratio (R), provide more satisfactory results.

To obtain representative sampling a reasonably large, skin-free foam specimen is preferred. For simplest preparation, a rectangular specimen is indicated. The local specimen has an original volume of about 3 cubic inches. It is a rectangular block 1.8 in. long (H) and 1.3 in. in width (W) and thickness (T), cut from the foam on a band saw and blown free of dust. An analytical balance is used for weighing specimens to the closest milligram; a dial indicator provides dimensions to closest 0.001 inch.

Throughout the physical operations, care is taken to avoid rupturing cell walls. Rough handling would be especially probable on the saw or when removing specimens from the R & P apparatus.

When the specimen's original Vd is determined in the displacement apparatus to the closest estimated 0.01 cc., it is returned to the saw. A single cut perpendicular to the long axis of the preferred specimen increases *R* from about 4 to about 5 reciprocal inches. This cut is normally made at the center of the specimen. Note that Eq. 7 is not affected by removal of the incremental volume of foam destroyed by the saw.

The new height and weight of the two specimen fragments are determined and a new measurement of Vd is obtained. In practice, the specimen is now returned to the saw where each piece is again bisected in a plane perpendicular to the original long axis. The resulting four pieces, with their overall *R* of about 8, are returned to the balance, the dial indicator, and the R & P apparatus. To obtain a fourth point at an *R* of about 14, the pieces of the original specimen are again bisected on the saw and reprocessed as a single specimen.

It is not presumed that the precision with which it is recommended that measurements be recorded is justified by the apparatus or technique employed. The approach has the double advantage of minimizing numerical rounding errors and encouraging careful laboratory operation.

Calculations: The experimental Oc at any *R* is simply the appropriate Vo/Vs(n) ratio. Vs(n) is the overall dial-indicator-measured specimen volume after *n* auxiliary saw cuts. For the recommended specimen treatment, the empirical *R* may be calculated most conveniently by means of the equation

$$R(n) = \frac{2\,(n+1)}{H - n\Delta H} + \frac{2}{T} + \frac{2}{W} \quad \textbf{Eq. 8}$$

This relationship is obtained directly from a knowledge of overall specimen geometry during the suggested operations. The only new variable is ΔH, the reduction in height of the stacked wafers of the original specimen due to material losses during a single auxiliary cut.

It is now possible to plot Oc(n) on the ordinate against R(n) on the abscissa of a graph. A straight line may be passed through the experimental points. The intercept on the ordinate at R = O provides a measure of *F* at the calculated specimen density; the slope of the line is the function of Vg indicated by **(To page 212)**

Definitions of alphabetical terms

A — Geometric or nominal surface area of a foam specimen determined by external measurement (sq. in.).

Df — Density of a foam specimen (lb./cu. ft.).

Dg — Effective density of the gas within a foam specimen.

Dp — Density of the polymer constituting the foam.

F — Fraction of completely interconnected (open) cells in the interior of a foamed product.

H — Height of a foam specimen (in.)

n — Number of auxiliary cuts made in a specimen.

N — Number of cells in a unit volume of foam.

Oc — Apparent volume fraction of open cells in a foam specimen of fixed dimensions.

R — Geometric surface-to-volume ratio of foam specimen ($in.^{-1}$).

T — Thickness of a foam specimen (in.)

V — Overall volume associated with an average cell.

Vd — Total volume of air displaced by a foam specimen of fixed dimensions.

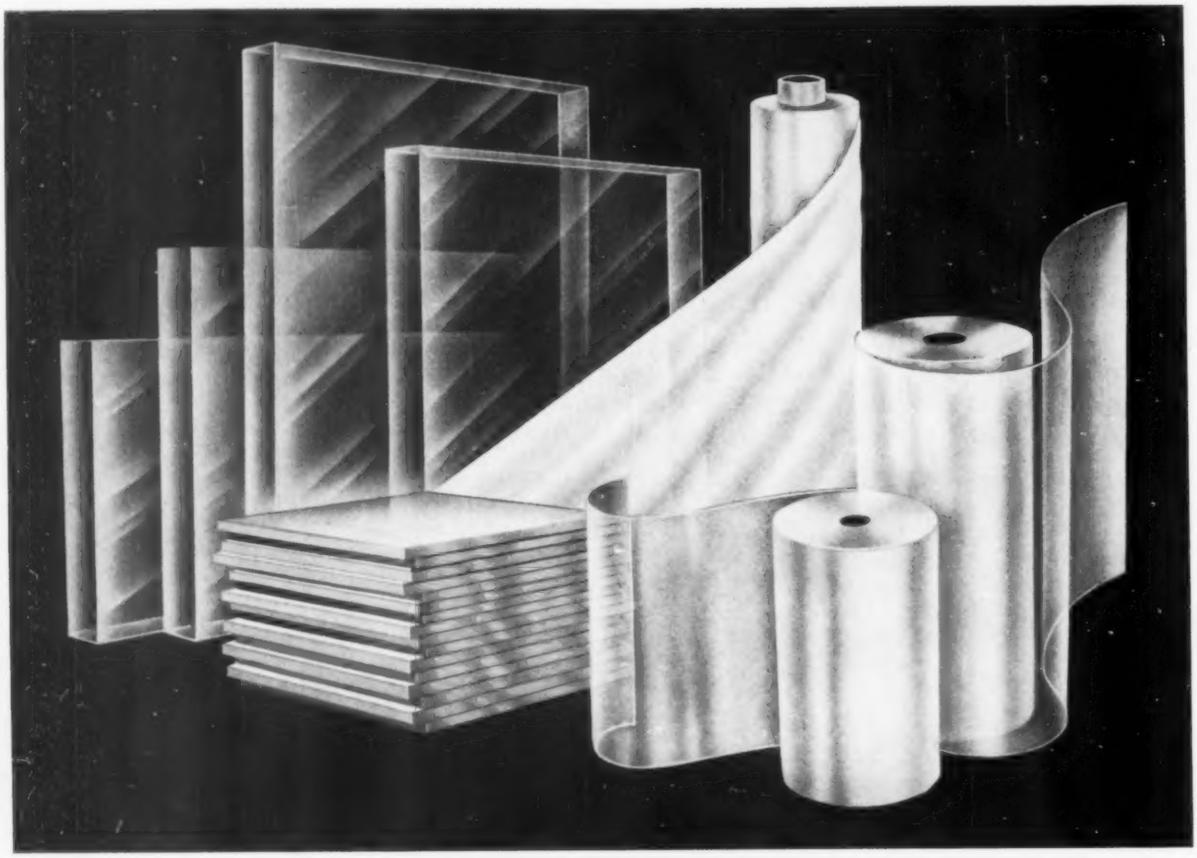
Vg — Gas volume associated with an average foam cell (cc.).

Vo — Apparent total volume of open cells in a foam specimen of fixed dimensions.

Vp — Volume of polymer solids associated with an average foam cell.

Vs — Geometric or nominal volume of a foam specimen, determined by external measurement (cu. in.).

W — Width of a foam specimen (in.).



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Plexiglas & Acetate with Embedments		X	X		
PVC		X	X	X	X
Polypropylene		X	X		
Polyethylene—Regular	X	X	X	X	X
Polyethylene—High Density		X	X		
Propionate		X	X		
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That age-old question has received a brand-new answer with the introduction of injection molded polystyrene "drapes." Based on a 3-in.-sq. module of light-stabilized material, the new covering combines the functions of blinds, draperies, shades, and curtains. In addition, it offers infinite decorating possibilities in the area of room dividers and folding doors.

Manufactured by Jaylis Industries Inc., Los Angeles, Calif., and known as Jaylis traversing draperies, the new decorative medium is produced in any required size by assembling the interlocking square modules on vertical spring steel rods. Widths and lengths are virtually unlimited, governed only by the number of molded polystyrene squares used horizontally and vertically. The entire assembly is suspended on nylon rollers from standard heavy-duty drapery tracks.

The squares are molded of Dow's Styron 671 Verelite, a light-stabilized material which, incorporating inorganic color pigments, is reported to have a fade resistance many times greater than that of dyes used in fabrics. Thus it is claimed that the draperies will outlast any other window covering on the market, giving many years of trouble-free service while maintaining initial freshness and beauty. It is further stated that the low ultra-violet and infra-red transmission properties of the material block out 99% of the rays of the sun that fade furnishings and 86% of the heat; since heat is controlled at the point of entry or exit, air conditioning and heating requirements are reduced substantially. Also, when Jaylis draperies are used at windows, outdoor awnings and other heat and light control elements are unnecessary.

Although the translucent material used filters out harmful sun rays, it permits passage of a soft diffused light. Horizontal molded-in vents, which are an integral part of the pattern, permit ventilation yet are so designed as to afford visual privacy to the user.

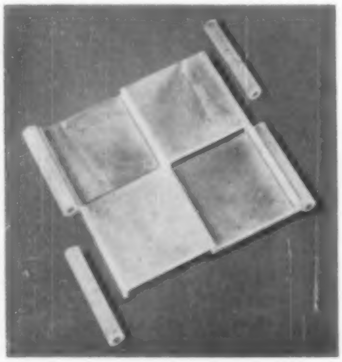
The unusual design of the modules is shown in accompanying photographs. Integral cylinders, 1½ in. long, are molded in on two opposite edges to accommodate the mounting rods. Separately molded cylinders serve as spacers when the squares are assembled.

The modules are produced in a variety of colors and patterns so that the appearance of the final decoration can be as varied as desired. Not only can odd-sized areas be perfectly fitted by using the correct number of squares, but draperies, screens, or room dividers can be economically and easily resized, and it is no longer necessary to abandon them when moving just because they are not the right size for the new home. While the polystyrene material is highly resistant to breakage, modules are easily replaced in case of damage.

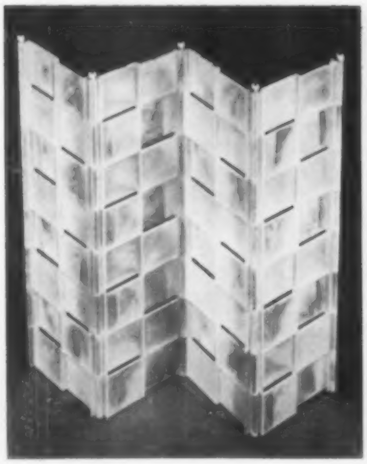
Jaylis draperies are not inexpensive in first cost—a 36- by 84-in. unit is listed by the manufacturer at $54.81—but it is claimed that the permanence of the material, low cost of maintenance, and savings in air conditioning and heating allows them to compete, in the long run, with the most inexpensive of window coverings available.

Urethane for respirator

Molded polyurethane foam, selected for high-temperature insulating qualities and light weight, houses a new industrial respirator which acts on a heat exchange principle. Use of the respirator permits increased working time in such areas as drying kilns and (To page 166)



RESTAURANT WINDOW AREA is fully covered with modular styrene drape. A section assembled of 16 modules is shown left below. A single module, with its associated spacers, is at left above.



(From page 164)

lab test rooms, where safe breathing for personnel under high temperature conditions is required.

The complete respirator, made by American Optical Co., Southbridge, Mass., consists of a cylinder-shaped foam shell into which are fitted 65 layers of aluminum screening and a perforated metal outer plate to lock the screens in place. A threaded metal ring, cemented to the top of the foam shell, enables the respirator to be screwed into the clear face piece of an asbestos hood. Price of the respirator is $7.90.

As the wearer inhales, hot air is drawn through the screen layers, which absorb much of the heat and reduce the temperature of the air reaching the mouth to approximately 100° F. Exhalation pulls heat from the screens and cools the cartridge for the next breathing cycle. In this way, workers can perform necessary tasks in temperatures up to 300° F. for periods up to a half hour. The respirator can be used in low temperature areas; here the heat exchange principle is reversed, and cold air inhaled is made comfortable by the warmer aluminum screens.

The polyurethane foam cylinder is molded at the Putnam, Conn. plant of American Optical, which uses aluminum molds of their own manufacture. The molds are hand-filled with a polyester and catalyst formula, which cures in 30 minutes. This formula is supplied in two-component form by Emerson & Cuming Inc., and is based on diisocyanates produced by National Aniline Div., Allied Chemical Corp.

Thermoformed relief maps

World and United States maps, showing terrain features in three-dimensional relief, are vacuum formed from vinyl sheet by Aero Service Corp., Philadelphia, Pa. Both maps measure 28 by 18 in., and are said to be the first produced in this size.

The horizontal scales are 962 mi. to the inch for the world map, and 117 mi. to the inch for the U. S. map. Vertical distance scales are exaggerated about 50 times to show terrain in relief up to ½-in. high.

Each map is lithographed in eight colors, including a mahogany-colored "frame," on 15-mil white vinyl sheet. Vacuum forming is done by Aero using equipment from Autovac Div., National Tool Co., Bridgeport, Conn., and also equipment of their own design and manufacture. This equipment will form vinyl sheet up to 48 by 72 inches.

After the map is formed, it is electronically sealed at the edges to a second 15-mil vinyl sheet, which contains a die-cut slot. A map index, lithographed in black on 10-mil high impact styrene sheet, is inserted through this slot into the space between the two vinyl sheets. The front of the map is then sprayed with a clear acetate lacquer to protect it against dust and dirt.

Price of the maps is $9.95 each. Vinyl and styrene sheet is supplied by Seiberling Rubber Co., Newcomerstown, Ohio. Sealing equipment is made by Electronics Corp., Brooklyn, N. Y. Lithography is done by Albert J. Becker, Southampton, Pa.

Epoxy-set brushes

A method of setting paint brush bristles with epoxy resin eliminates the oven curing required with rubber-setting methods, and results in a better product for the Brush Div. of the Pittsburgh Plate Glass Co., Baltimore, Md.

The previously-used vulcanization of rubber-setting compounds called for temperatures of 275° F. over a period of 15 to 24 hr., which often caused loss of oil in natural bristle brushes and unevenly distributed bristles in synthetic filament brushes. The epoxy resin cures in a few hours at room temperature, and will not shrink in the metal ferrule after cure is finished. Epoxy-set bristles also stand up better than rubber-set bristles in applications involving volatile paint solvents.

EPOXY RESIN for bristle setting is dispensed by automatic pump into ferrules of paint brush. Compound will cure within a few hours at room temperature.

Despite the higher cost of epoxy resin, prices of the epoxy-set brushes are said to be competitive with the rubber-set brushes. It is further said that the competitive costs are due to the more efficient production of paint brushes with the epoxy setting method.

The epoxy compound, based on Shell Chemical's Epon resins, is supplied by H. V. Hardman Co., Belleville, N. J. The compound, known as Eposet, costs 79¢/lb. and has a pot life of about 20 minutes. The Hardman firm also supplies curing agent and an automatic pump that mixes, meters, and dispenses the epoxy compound and curing agent in the proper proportion.

PE pipes save 75% labor

It's not necessarily the industrial giant that proves the inherent economics of plastics. Here is the case of a modest-sized water treating service company that went from galvanized metal to medium-density polyethylene for the piping in its ion exchange resin reconditioning plant, and in the process realized significant savings. While the actual installation involved only 400 ft. of pipe, the cash savings came to $500, which, at more than $1 per foot, represents worthwhile economies. And the experience (To page 168)

BEFORE AND AFTER. At left is galvanized metal pipe which was originally used in reconditioning system. Severe corrosion made frequent maintenance and replacement necessary. At right is a section of polyethylene pipe. Both are shown after one year's service.

suggests that other users may accomplish corresponding savings in their pipe operations.

In this particular installation, the pipe carries a brine solution under 50 p.s.i. at ambient temperature, as well as water and ion exchange resin. The polyethylene pipe resin is supplied by Union Carbide Plastics Co.; the pipe is extruded by Triangle Conduit & Cable Inc., New Brunswick, N. J.; and it is distributed by Aaron & Co., New Brunswick.

For the user, Consumer Heating and Plumbing Co., Summerville, N. J., the polyethylene pipes solved a serious corrosion problem at a saving in cost. Stainless steel, which also would have solved this problem, would have cost considerably more than the PE installation. Labor was reduced because of the light weight of the pipe one-fifth that of steel); need for fewer joints (because of flexibility); elimination of threads (pipe is joined by expandable metal clamp), as well as several ease-of-handling features.

. . . And in brief

• Series of fuseholders, blown fuse indicating, and non-indicating, are molded by Engineered Plastics Inc., Watertown, Conn., of Plaskon alkyd molding compound for Fuse Indicator Corp., Boston, Mass. The Blow-Glow fuseholders are said to have the high arc and insulation resistance and dielectric values sought by the military services for high altitude missile as well as rocket applications.

• Toy baby bath set, molded of polyethylene, is scaled to the needs of the 8-in. doll which comes along with the bath, bassinet, and covered diaper pail. Manufactured by Kiddie Brush & Toy Co. Inc., Jonesville, Mich., from material supplied by Eastman. It retails at $1.98.

• Swept-back-style series of marine windshields for run-a-bout boats is now thermoformed of Plexiglas methacrylate sheet by Premier Plastics Mfg. Co. Inc., Minneapolis, Minn. Available in heights from 12 in. to 22 in., the stock shields fit boats with deck widths from 46 in. to 78 inches. Custom made units are available for others.

• Called the Dy-O-Rama, a 46- by 48-in. landscaped HO model railroad layout is now being molded from Koppers Dylite expandable polystyrene by Life-Like Products Inc., Baltimore, Md., at $24.95, complete with track. It can easily be carved to modify the original scene.

• Large-scale models for the display industry (6-ft. bowling pins, 7-ft. hot dogs, etc.) are now molded in reinforced plastics by Tobincraft, Cleveland, Ohio, using Vibrin polyester resin made by the Naugatuck Chemical division, United States Rubber Co.

• Resin-bonded fibrous glass in a continuous rotary dryer has eliminated corrosion from hydrochloric acid and water vapors. Fabricated by du Verre Inc., Arcade, N. Y.

• Flexible vinyl jar opener from W. L. Gill Co., Redlands, Calif., is a 2-in.-deep cone with five interior gripping ledges from 1⅛ to 3⅝ in. I. D. The 2-oz. opener lists for 49¢, comes in red, yellow, blue, and green. Item is injection molded of Goodrich Geon vinyl by Molded Products Div., Stauffer Chemical Co., Los Angeles, Calif.—End

LITERATURE

Write for these publications to the companies listed. Unless otherwise specified, they will be sent gratis to executives who request them on business stationery.

"Polyester Resins" *by J. R. Lawrence.*

Published in 1960 by the Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. 251 pages. Price: $5.75.

Another book in the Reinhold Plastics Applications series, this work on polyesters serves the useful purpose of putting a great deal of information in one place. Requiring only a basic knowledge of chemistry, the book is very readible and covers all the important subjects adequately. Included are chapters on the chemistry, properties, resin manufacture, formulation and compounding, and fabricating processes pertinent to the technology of polyester resins. Three appendixes and additional tables of data throughout the book provide the reader with much useful information. This publication is worth having if you're in the polyester business or want a good primer on the subject.—*G.R.S.*

"Thermoplastics" *by Heinz Mandler.*

Published in 1959 by VEB Carl Marhold Verlag, Halle (Saale), East Germany, in German under the title "Duroplaste." 174 pages. Price: DM 13.55 ($3.50).

Written as a guide to engineers and designers responsible for saving material costs to fulfill the Five-year Plan of the Russian Zone of Germany, this volume is a concise presentation of the properties, processing techniques and test methods for thermoplastic materials. Mechanical and physical properties are presented graphically and in table form. The book contains approximately 116 diagrams and illustrations.

"The Plastics Industry of Switzerland" Volume II.

Published in 1960 by Verlag fuer Wirtschaftsliteratur G.m.b.H., Zurich, Switzerland, in German, as "Die Kunststoff-Industrie der Schweiz." 200 pages. Price: $5.50.

The main section of this volume is an alphabetical listing in German of Swiss suppliers and manufacturers of plastics products and machinery; translations appear under the German headings. A listing of importers and distributors, showing products handled by them, and the companies they represent; a brief outline of plastics raw materials produced in Switzerland; and an alphabetical listing of tradenames; are also provided. Volume I, which appeared earlier, is a listing of Swiss plastics manufacturers.

"Plastics in Austria."

Published in 1959 by Julius Dressler, Vienna, Austria, in German as "Kunstoffe in Oesterreich." 225 pages. Price: about $8.00.

This small volume is a reference book combined with a directory of Austrian manufacturers of plastics materials and machinery. Property charts, specifications, and informative articles about major applications for plastics materials are included. All listings are in German and no English vocabulary or index are provided.

Diallyl phthalate. Colors and forms available, molding data, molding and electrical properties; uses, etc., for a line of Diall diallyl phthalate molding materials: Diall 50-01 (Orlon filled); Diall 50-51 (Dacron filled); Diall 51-01 (asbestos filled); Diall 52-01 (glass filled, short fiber); Diall 52-20-30 (glass filled, long fiber); and others. 12 pages. *Mesa Plastics Co., 11751 Mississippi Ave., Los Angeles 25, Calif.*

Industrial plastics. Properties and application data for the complete warehouse availabilities of Polypenco industrial plastics—nylons, TFE fluorocarbons, polycarbonates, chlorinated polyethers, and cross-linked polystyrene. Includes data on Fluorosint, a TFE-based resin. 12 pages. *The Polymer Corp. of Pa., Reading, Pa.*

Production facilities. "Engineered Reinforced Plastics Structures and Components" describes the production facilities and services available —plastics engineering, manufacturing facilities, structural, tool making, precision forming and molding, and metal bonding. 16 pages. *Fairchild Plastics Branch, 1275 Marconi Blvd., Copiague, N. Y.*

Phenolic laminate. Grade selection table; application, physical, and electrical properties; tolerances of molded and sanded plate; standard plate size, decimal equivalents; and other technical data for Micarta paper and fabric grades of sheets, angles, channels, zees, and rods. Bulletin 63-060. 4 pages. Similar data for asbestos and glass grades (Bulletin 63-061, 4 pages); and molded rod (Bulletin 63-360, 2 pages). *Westinghouse Electric Corp., Micarta Div., Hampton, S. C.*

Epoxy compounding. "The Techniques of Using Epoxy Plastic Tooling Materials" is a manual showing how a line of epoxy materials can be used to produce master Keller models, master duplications, prototypes, and other tooling units. Approximately 50 illustrations. *Ren Plastics Inc., 5422 S. Cedar St., Lansing 9, Mich.*

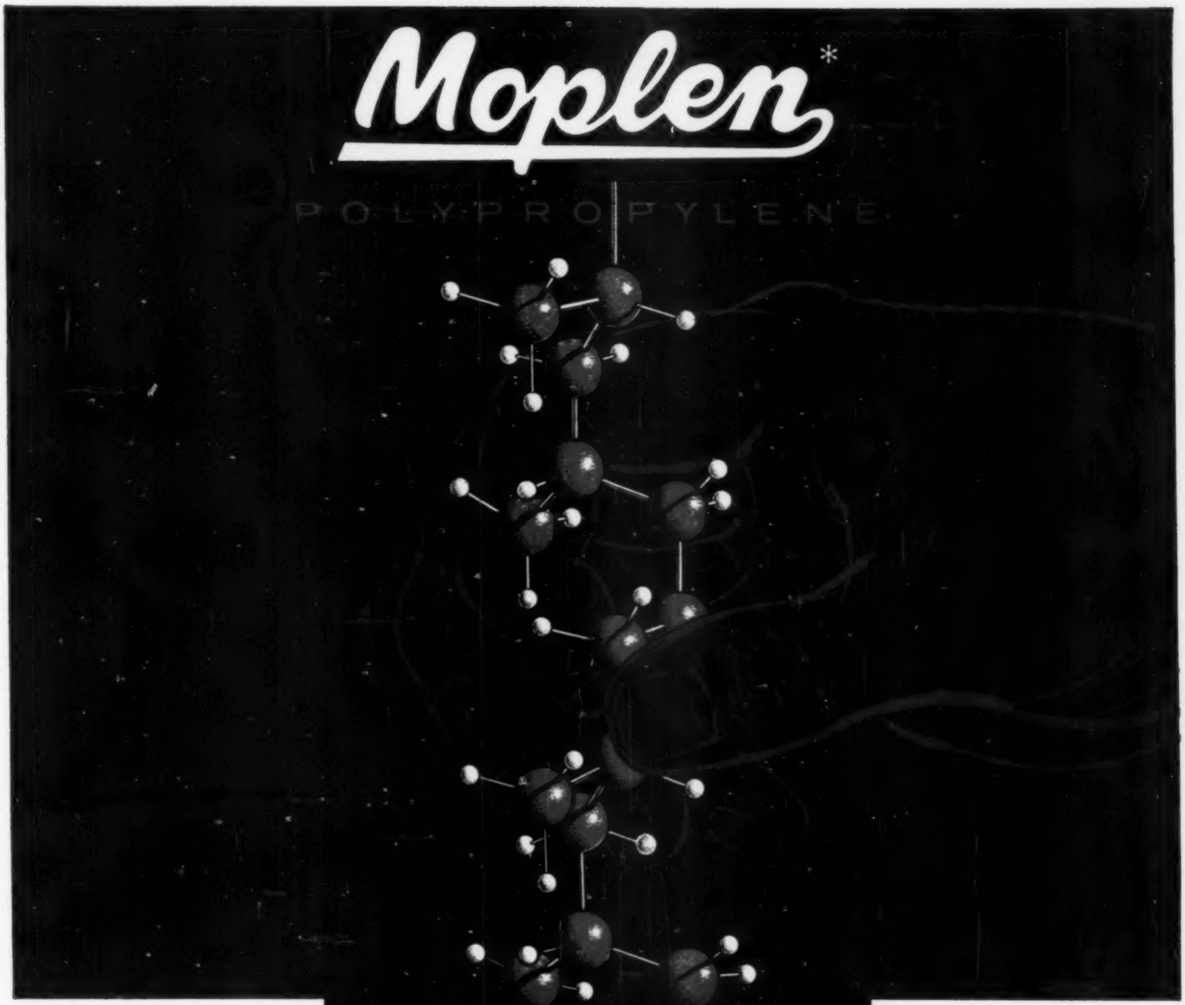
Roll leaf stamping. Booklet contains two technical papers—"Hot Leaf Stamping" and "Developments in Finishing Molded Plastics by the Roll Leaf Stamping Method"—relating to the process of finishing, decorating, etc., molded plastics. 12 pages. *OlsenMark Corp., 124-132 White St., New York 13, N. Y.*

Vinyl panels. Sizes and thicknesses available, patterns, uses, and a sample swatch for Panlam translucent vinyl decorative materials made by Polyplastex. Uses include partitions, illuminated ceilings, space dividers, folding screens, displays, window treatments, etc. 4 pages. *Kerber Enterprises Co. Inc., 132 Spring St., New York 12, N. Y.*

Laminated plastics. Brochure discusses numerous uses for fabricated parts that can be punched, machined, ground, drilled or turned from Insurok sheet, tubes, and rods; outlines the company's fabrication service and compression molding facilities. Catalog 20.000.13. 8 pages. *The Richardson Co., 2731 Lake St., Melrose Park, Ill.*

Molding facilities. Outlines the company's molded products service, which includes design of the part, design and fabrication of the mold, and molding of the part. 8 pages. *Formica Corp., 4614 Spring Grove Ave., Cincinnati 32, Ohio.*

Vinyl stabilizers. Bulletin is designed to help plastics engineers and formulators to select vinyl stabilizers for various applications. Includes technical data on the use of these stabilizers in calendering, extruding, and injection molding **(To page 172)**



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(From page 170)

applications, as well as in plastisols and modified plastisols. 18 pages. *The Harshaw Chemical Co., 1945 E. 97th St., Cleveland 6, Ohio.*

Polyester-epoxy rods, tubes, and shapes. Features, uses, sizes, etc., for a line of Polygon Glasdramatic RP rods, polyester and epoxy shapes, etc. 4 pages. *Polygon Plastic Co., Walkerton, Ind.*

Vacuum gages. Principles of operation, advantages, pressure ranges, etc., for a line of vacuum gages, which are used in vacuum metallizing and other processes. Catalog 175. 6 pages. *Hastings-Raydist Inc., Hampton, Va.*

Plastics in Refrigeration. Bulletin contains two papers delivered at Domestic Refrigerator Engineering Symposium of ASHRAE, Feb. 1, 1960, in Dallas, Texas. "Realistic Properties of Plastics Materials Applied to the Requirements of the Refrigeration Industry" and "The Assurance of Satisfactory Performance of Plastics Parts in Refrigeration." 50 pages. Price: 1-10 copies, \$1.00 each; 10-25, 75¢ each; 25-100, 60¢ each; 100 or over, 50¢ each. *The Society of the Plastics Industry Inc., 250 Park Ave., New York 17, N. Y.*

Molding machines. Specifications, uses, etc., for a line of injection, compression, transfer, and reinforced plastics molding machines. Bulletin 6030-B. 6 pages. *The Hydraulic Press Mfg. Co., Mount Gilead, Ohio.*

Copper-clad laminate. Physical, mechanical, and electrical properties; dimensional data on thickness of the copper foil and overall sheet size; results of bond strength; hot solder and oven testing for heat resistance, and insulation resistance tests; and other technical data for Grades 320-R and 320-E, a new hot-punch copper-clad laminate. Bulletin 3.1.8.2. 2 pages. *Taylor Fibre Co., Norristown, Pa.*

Thermocouple Data Indicator. Graphic calculator gives millivolt values for different types of thermocouples; conversion of B&S wire gage into millimeters and decimal inches; pipe sizes, including outside diameters and wall thickness for standard, extra heavy and double extra heavy pipe; ISA wire type designations and color codes; maximum temperatures for common thermocouple protection tubes; thermocouple polarity; Fahrenheit-Centigrade conversion; and standard C and D scale slide rule. Price: \$2.00. *West Instrument Corp., 4363 W. Montrose Ave., Chicago 41, Ill.*

RP pipe. General description, chemical resistance, versatility, properties, uses, etc., for a line of fibrous glass-reinforced armored pipe that is used for chemical corrosion control. Bulletin FRP-1. 4 pages. *Haveg Industries Inc., 900 Greenbank Rd., Wilmington 8, Del.*

Smoothing and polishing media. Specifications, uses, case histories, etc., for a line of resilient rubber bonded abrasive wheels, points, and sticks for micro-deburring, smoothing, and polishing plastics and other materials. 26 pages. *Cratex Mfg. Co., 1600 Rollins Rd., Burlingame, Calif.*

Nylon bobbins, washers. Specifications, uses, and features of a line of nylon bobbins and washers. 4 pages. *Cosmo Plastics Co., 3239 W. 14th St., Cleveland 9, Ohio.*

Polyolefin moldings. Block and rod sizes, weights, prices, etc., for a line of large polyolefin moldings, used for neutron moderation and shielding, product prototypes, and for original equipment components. 4 pages. *American Agile Corp., P. O. Box 168, Bedford, Ohio.*

Mylar film. Physical strength, chemical resistance, thermal range, dielectric strength, properties, applications, and other data, for Mylar polyester film. 8 pages. *Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich.*

Heat sealing of PE film. Technical data sheet lists the problems, causes, and corrective measures in heat sealing polyethylene film. 2 pages. *U. S. Industrial Chemicals Co., 99 Park Ave., New York 16, N. Y.*

Value Analysis of Printed Circuits. Booklet outlines the several functions that may be performed by the printed wiring board and describes the types of circuitry best adapted to this method of packaging as well as those where it shows up less favorably. 16 pages. *Arthur Ansley Mfg. Co., New Hope, Pa.*

Polyethylene. Properties, applications, prices, etc., for a line of high-, medium-, and low-density polyethylene resins. 4 pages. *Phillips Chemical Co., Bartlesville, Okla.*

Accumulators. Brochure explains why and how accumulators are used in a variety of hydraulic systems. Includes technical data on piston-type accumulators ranging in capacity from 10 cu. in. to 10 gallons. Bulletin 1530B1. *Parker Hydraulics Div., Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio.*

Melamine. Specifications, analytical methods, packing, physical properties, chemistry, applications, references, and bibliography for this company's melamine. 26 pages. *British Oxygen Chemicals Ltd., Bridgewater House, Cleveland Row, St. Jame's, London SW1, England.*

Speed variator. Features, dimensions, applications, hp. ratings, etc., for Paramatic Speed Variator, which is used for a variety of drive applications in the plastic, rubber, and other industries. Bulletin GEA-7012. 8 pages. *General Electric Co., Schenectady 6, N. Y.*

ABS resins. Types available, prices, colors, etc. for Cycolac acrylonitrile-butadiene-styrene resins for molding, extruding, calendering, and vacuum forming. 6 pages. *Marbon Chemical, Div. of Borg-Warner, Washington, W. Va.*

Reinforced phenolic laminates. Specifications, tensile test and flexural bending data, and other technical data relating to TRC-X reinforced phenolic laminates. 2 pages. *Riverside Plastics Corp., 220 Miller Rd., Hicksville, N. Y.*

Hardness testers. Specifications, accessories, uses, etc., for a line of motorized hardness testers which provide both regular and superficial Rockwell hardness testing in a single machine. Bulletin CRS-60. *The Torsion Balance Co., Clifton, N. J.*

Hydraulic presses. Specifications, features, uses, etc., for a line of hydraulic presses. Includes 125-ton plastic molding press; 80-ton plastic trim press. 8 pages. *St. Lawrence Hydraulic Co., 22043 Van Born Rd., Taylor, Mich.*

Olefins product guide. Tabulates physical properties for 1,3-butadiene, ethane, ethylene, methane, propylene, biphenyl, dicyclopentadiene, naphthalene, tetrahydronaphthalene, toluene, unsaturated oil, calcium hydroxide, calcium oxide, acetylene, and calcium **(To page 175)**


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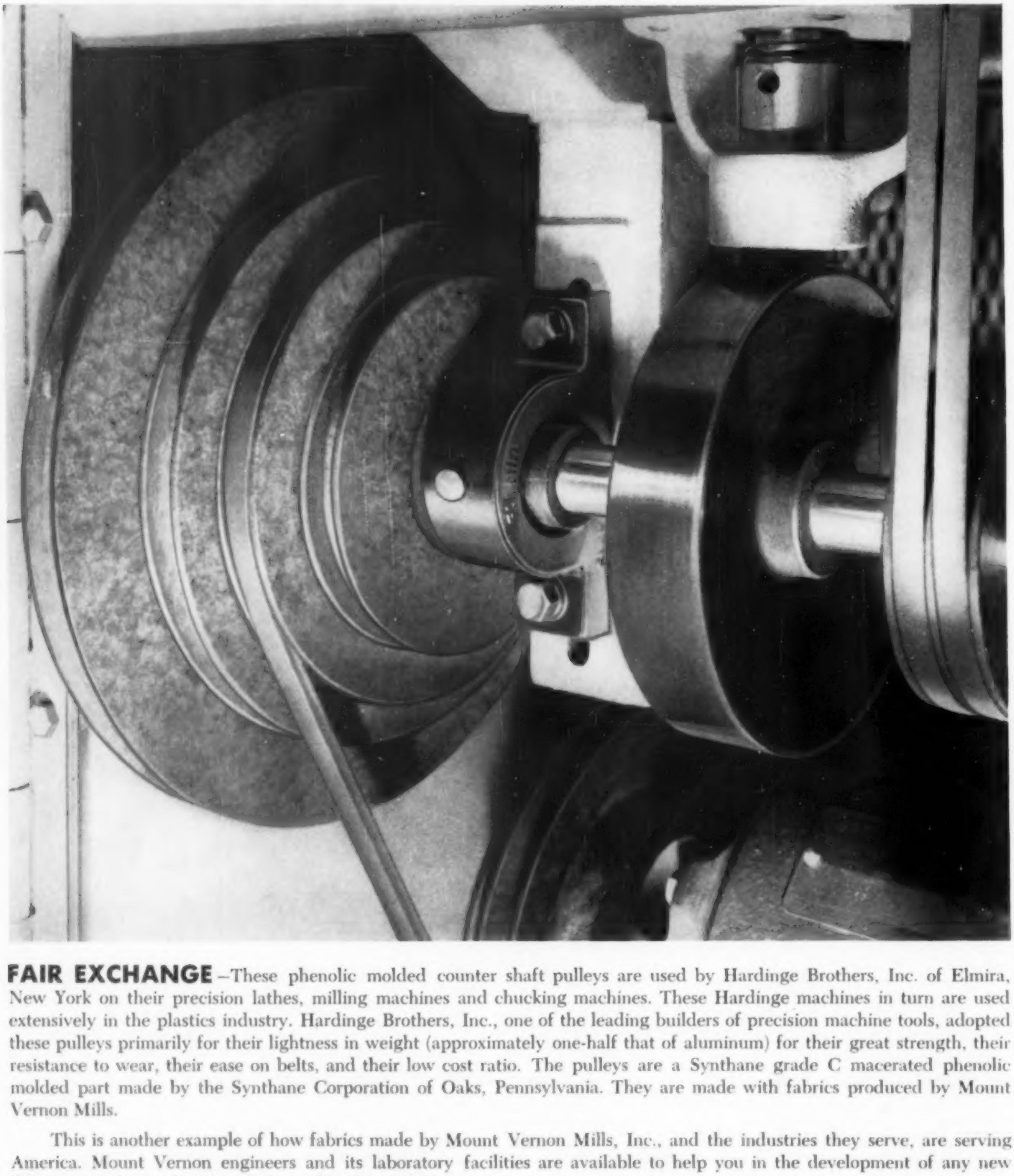

FAIR EXCHANGE—These phenolic molded counter shaft pulleys are used by Hardinge Brothers, Inc. of Elmira, New York on their precision lathes, milling machines and chucking machines. These Hardinge machines in turn are used extensively in the plastics industry. Hardinge Brothers, Inc., one of the leading builders of precision machine tools, adopted these pulleys primarily for their lightness in weight (approximately one-half that of aluminum) for their great strength, their resistance to wear, their ease on belts, and their low cost ratio. The pulleys are a Synthane grade C macerated phenolic molded part made by the Synthane Corporation of Oaks, Pennsylvania. They are made with fabrics produced by Mount Vernon Mills.

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carbide; outlines methods of shipment for each product. 4 pages. *Union Carbide Olefins Co., 30 E. 42nd St., New York 17, N. Y.*

Sheets, rods, tubes, and film. Catalog gives sizes, prices, etc., for a complete line of Plexiglas, vinyl, acetate, phenolic, nylon, Teflon, Kel-F, polyethylene, polystyrene, Rexolite, and Delrin sheets, rods, tubes, and film. 64 pages. *Commercial Plastics & Supply Corp., 630 Broadway, New York 12, N. Y.*

Laminated Plastics Selection Guide. Part A—"How to Specify and Order High-Pressure Laminated Plastics." 12 pages. Part B—"Characteristics Chart of Laminate Grades." 6 pages. *Taylor Fibre Co., Norristown, Pa.*

The Resistance of Sheet Insulation to Surface Discharges. The resistance of thin materials to breakdown by surface discharges has been examined by three methods at temperatures between 20 and 140° C. Majority of tests were made on thin films of eight plastic materials, but a few tests on thicker sheets of silicone rubber, Perspex, and synthetic resin bonded laminates are also reported. Technical Report L/T379. Price: $2.25. 30 pages. *The Electrical Research Assn. Laboratory, Cleeve Rd., Leatherhead, Surrey, England.*

Blow molding machine. Specifications, air and electrical requirements, features, etc., for dual-manifold blow molding machine. Bulletin 291. 4 pages. *F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.*

Temperature and pressure recorders. Features, pressure and temperature elements, dimensions, specifications, etc., for a line of pressure and temperature recorders. Catalog 800. *U. S. Gauge Div., American Machine and Metals Inc., Sellersville, Pa.*

Injection molding machine. Specifications, features, and case histories for NATCO injection molding machine. Bulletin 1000. 12 pages. *National Automatic Tool Co. Inc., Richmond, Ind.*

Silicones. Engineering guide to the forms, properties, and applications for a line of silicones. 16 pages. *Dow Corning Corp., Midland, Mich.*

Hot-melt, water soluble compounds. Cost and time analysis, uses, etc., for a line of hot-melt, water-soluble compounds for producing mandrels for the fabrication of reinforced plastics ducts, filament wound pressure vessels, and **(To page 177)**

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similar applications. Bulletin RPD 1000. 4 pages. *Rezolin Inc., 1651 Eighteenth St., Santa Monica, Calif.*

Handling C_4 Hydrocarbons. Physical properties, shipping methods and information; general unloading techniques; fire, explosion, and toxicological hazards; shipping instructions for tank trucks, cars, and barges; etc., regarding C_4 hydrocarbons. Flammable C_4 hydrocarbons require somewhat different handling facilities than do the heavier oils. 36 pages. *Petro-Tex Chemical Corp., Houston 1, Texas.*

Plastic lab ware. Sizes, uses, prices, etc., for a line of PE, polypropylene, polyurethane, polyvinyl, and nylon laboratory apparatus. Catalog H459. 24 pages. *Dynalab Corp., 625 Goodman St. S., Rochester 1, N. Y.*

Insulating resins. Thermal properties, curing method, filler, pot life, hardener, physical and mechanical properties, features, etc., for a line of epoxy and urethane resins for electrical applications. 2 pages. *Marblette Corp., 37-31 Thirtieth St., Long Island City 1, N. Y.*

Drum mixing equipment. Dimensions, tumbling speed, shipping weight, capacities, hp., uses, etc., for a line of drum tumblers and rollers, which are used for mixing and blending various liquids, powders, granules, and other solids. Bulletin DM-290. 12 pages. *Process Equipment Div., U. S. Stoneware Co., Akron 9, Ohio.*

Portable pneumatic unloader. Dimensions, uses, and features of the Portaflow portable pneumatic unloader for transfer of all types of dry, pulverized, and granular resins and other materials. Bulletin 126-B. 4 pages. *Sprout, Waldron & Co. Inc., Muncy, Pa.*

Self-locking fastener. Thread and hole size, length, inserting force, holding power, screw size, uses, etc., for the Torq-Loc screw insert, which is used in plastics and other applications. 2 pages. *Torq-Loc Div., Bergen Laboratories Inc., Paterson, N. J.*

"Noise Reduction and Bar Stock Protection with Byers PVC Stock Tubes" contains "before" and "after" results of an installation in which PVC stock tubes replaced metal stock tubes on a 6-spindle automatic screw machine. Machine shop noise can reportedly be reduced from 83 to 88% with this system. 8 pages. *A. M. Byers Co., Clark Bldg., Pittsburgh 22, Pa.*—**End**

New Machinery

(*From pp. 48-54*)

two 4½ v. dry cell batteries. Price $275 f.o.b. mfr. *The Simco Co., 920 Walnut St., Lansdale, Pa.*

Web press

Adapted to plastic, paper, and metal stock, Model P-50 die cutter handles a 50-in. web width of stock in thicknesses from 0.0005 in. to any thickness that is available in web or roll form. The P-50 has speeds up to 200 platen strokes/min. and at its maximum, with automatic sheeter, is capable of producing 12,000 sheets—50 by 50 in. per hour. This web size makes it possible to produce more individual pieces per stroke and also permits the handling of very large pieces. Waste is held to a minimum. Low-cost steel rule dies that will produce millions of pieces are used. The P-50 can be furnished with printers for printing both sides at one time or one side in one or more colors. Embossing equipment, stitchers and gluers are also available. In addition to the Model 50, presses also come in 12 in. and 24 in. web width sizes. *Karr Engineering Service Inc., 2920 W. Clybourn St., Milwaukee, Wis.*

Linear speed control

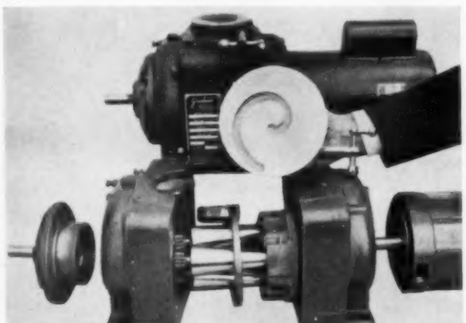
A new type of control for Graham transmissions used on extruders provides equal changes in speed for equal increments of control adjustment. This new control, while providing linearity, also insures high-accuracy setting and holding of speed over a range from any desired maximum to zero—plus reverse if desired. A roller carrier, fixed to the motor shaft, supports three tapered rollers which are engaged by an encircling traction ring. Pinions fixed to the large end of the rollers engage a ring gear joined to the output shaft. To change speed, the traction ring is moved lengthwise of the transmission, engaging the rollers at varying diameters. The control cam produces equal speed changes for each increment of movement of the micrometer control handle to provide control linearity. Once set, the transmission holds speed with change in load. Regulation is comparable to that of an induction motor. Because traction between ring and rollers is developed centrifugally, drive speed may be changed while running. Differential action makes possible stalling of the output shaft (as would be caused by jam or overload) without damage to the rotating parts. Skid or slippage cannot occur at one contact point and the transmission thus protects both itself and the driven machine against overload damage. The transmission is available with or without motor. It can be furnished with built-in spur reducers having parallel shaft extension or with worm reducers with right angle extension. Micrometer, remote mechanical, electrical, or pneumatic controls may be specified. A photograph of the unit appears below. *Graham Transmissions Inc., Menomonee Falls, Wis.*

Mold release

Called Super "A" silicone mold release, this material is described as a release for all types of resins used in laminating, casting, and pressure molding. It comes in a 20-ounce pressure can for convenient spray application. It is heat-stable, oxidation resistant, and virtually non-volatile. It is suited for use on prepared non-metallic surfaces and metallic surfaces up to 500° F. and gives clean, easy release to a wide variety of plastics, including epoxy, melamine and phenolic resins. Swivel action handles for the pressure cans are also available from the company. *Hastings Plastics Inc., 1551-12th St., Santa Monica, Calif.*

Casting oven

Designed to eliminate air and moisture from plastic castings by allowing the pouring to be done under vacuum, this oven is designed to accommodate four or more molds. These are placed on **(To page 180)**



GRAHAM linear variable speed transmission showing tapered rollers which drive friction ring and control cam.

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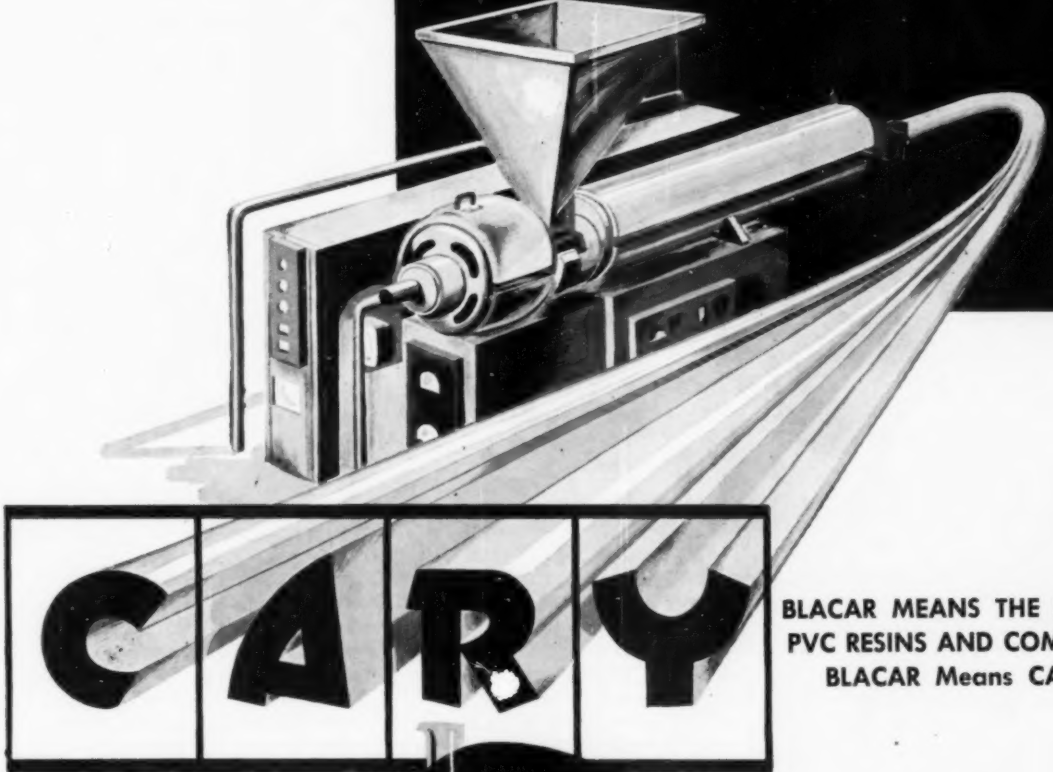

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individual tables which can then be positioned for filling from the outside. The casting material can be catalyzed and put into pouring cup, heated, de-aerated, poured into mold, and finish baked. All this can be done at thermostatically controlled temperature up to 500° F. and vacuum of 29 in. or more. The unit is jacketed for oil transfer heating. Oven has porthole-type front window, direct-reading heat and vacuum gages, and electric control switch. Controls, gages and oven entry are at front. *Metallizing Co. of America Inc., 3520 W. Carroll Ave., Chicago 24, Ill.*

Drill press

For postmolding fabrication of plastic parts, this air power feed drilling machine operates from shop air line, with 3-in.-diameter air cylinder providing a drill thrust of approximately seven times line pressure. Feed rate is hydraulically controlled and is continuously variable. Threaded adjustable sheaves on the motor and spindle drive provide spindle speeds from 600 to 4000 r.p.m. Unit comes complete with single- or three-phase motor, air controls, worklight, and oil groove table with raising mechanism. Can be had with #2 Morse taper spindle socket or ½-in. chuck. Inline feed cylinder gives more thrust at the drill point for the same size bore than units feeding through pinion shaft. *The Electro-Mechano Co., 241 E. Erie St., Milwaukee, Wis.*

Screen separator

Separation of processed parts and tumbling media can be achieved over a broad work range with the Model SS-4L screen separator machine. Variable speed drive permits adjustment from 145 to 350 reciprocations per minute, with screen movement variable 0 to 1½ inch. The compact machine is completely self-contained, motor driven, and has controlled feed with a 3 to 7° adjustable slide angle. Interchangeable square mesh screens are used, 31 by 60 in. overall. Other features include front loading and front discharge, ¾ hp. 220/440-v. three-phase motor, simple hand-wheel speed control, and heavy duty construction. Size of the Model SS-4L is: 10½ ft. long by 43 in. wide. Height of the unit to top of cradle is 44 in. above the floor. *Rampe Manufacturing Co., 14915 Woodworth Ave., Cleveland 10, Ohio.*

Sealing tool

For use in the lay-up of B-stage fibrous glass cloth over molds to form complex shaped parts, and in sealing plastic films, the Plasti-Form electrically heated tool is similar to a soldering iron and consists of a heated metal tube with handle, cord and five quick-attach heads in different shapes and dimensions. The quick-change capability enables this one tool to satisfy many of the lay-up and heating requirements for any job. The heater is double sealed to prevent contamination by plastic and solvent vapors, under severe production conditions. Tests by manufacturer indicate that the nominal head temperature of 400° F. provides good heating for most materials under all operating conditions, and that a temperature control is not necessary, since adequate control is obtained by adjusting the pressure and application time. Price complete with heads, $14.95 postpaid. *ERA Engineering Inc., 1009 Montana Ave., Santa Monica, Calif.*

Vacuum gage

For use in plastic metallizing equipment, battery-operated, transistorized vacuum gages with ranges of 0 to 1000 microns of mercury or 0 to 20 millimeters of mercury are available in portable or panel-mounted models. These gages provide continuous, rapid measurement of the pressure of a gas under vacuum. All models have an accurate, sealed, electrical indicating meter which reads pressure directly. Continuous readings may be made without affecting the pressure in the system. All models have a spring-loaded On-Off switch to prevent battery drain when the instrument is not in use. The gage tubes connect to the vacuum system by means of a standard ⅛-in. NPT male pipe thread. Matched and interchangeable gage tubes allow the user to monitor at multiple gage tube locations with one indicator, without recalibration or resetting of the instrument. *Hastings-Raydist Inc., Hampton, Va.*

Band heater

Ceramic insulated band heaters for injection molding and extruders are designed to meet the demands for higher processing temperatures. Since heat transfer is by radiation in contrast to the conventional conduction heaters, the temperature of the resistance wire is not affected by the part being heated or the manner in which the heater is installed. Pressure on the heating surface is not required. Service life has been reported to exceed 15,000 hours in most industrial process uses. Complete flexibility of this heater permits it to be attached to the component it is to heat, and eliminates the need of "two-half" or "hinged" assemblies. Heaters are **(To page 183)**

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General Features:

Hydraulic pumping unit completely enclosed in base.

All-steel welded construction. Maximum rigidity for accurate work.

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Dake air-operated, hydraulic laboratory presses are especially designed for laboratory testing and experimentation, and small parts production. They are low in cost, compact in design, and simple to operate. Like other Dake presses, these presses are engineered by men experienced in every phase of the plastic industry, who can help you meet special needs and requirements for every plastic molding operation. Laboratory presses are available in capacities from 25 tons to 75 tons; other presses, in capacities from 25 tons to 600 tons. Write for Bulletin No. 374.

25-Ton Dake laboratory press used to mold experimental resins in a Grand Rapids, Michigan, varnish company.

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manufactured to specification only. Diameters can be specified from 1½ in. up in any fractional increments—widths from 1 in. up in ½ in. increments. Ceramic band heaters are particularly recommended where watt density in the range of 40 w. per sq. in. are required. *Industrial Heater Co. Inc., 417-19 Canal St., New York 15, N. Y.*

Mold cooler-heater

The Multi-Tem unit can be used for alternately cooling and heating molds in either injection or compression work. The unit can also be set for non-cycling operation and will control temperature between 40 and 500° F. The equipment included consists of two pumps (hot and cold), a refrigeration unit, electrical heaters, thermostats, and electrical controls. The unit is furnished with manual control on cycling but can be equipped with timers for fully automatic operation. Two large oil storage tanks are an integral part of the equipment, one for cold oil and one for hot oil. Thus, cold or hot oil can be immediately pumped to the process piping by merely switching in either tank. This eliminates the need for waiting for the entire volume of heat transfer fluid to come to the new set temperature when making changes. Unit is completely self contained and requires only electrical hook in and hose connections. A range of capacities and power voltages is available. *Application Engineering Corp., P.O. Box 334, Park Ridge, Ill.*

Sheeter

Designed for automatic cutting of sheets from all soft and semi-rigid plastic films, at production rates of up to 2300 per hr., the Kiefel sheeter is engineered to meet the requirements of both the large and small converter. Construction of the machine is such to make it suitable for installation at the discharge end of extrusion takeoff trains and calendering lines. Handling roll widths of up to 57 in. and diam. of up to 10 in., the unit automatically produces sheets in any length up to 31½ in. within an accuracy range of ± 1%. The sheeter is powered by a 220 v., 60 cycle, ¼ hp. gearmotor and will handle gages from 0.004 to 0.040 inch. Simple to set-up and operate, the unit is particularly adaptable to short runs and allows operation by unskilled personnel after only a minimum of training. Suggested by manufacturer as means of evening out machine loadings during periods of peak production. *Leedpak Inc., 294 Fifth Ave., New York 1, N. Y.*—**End**

Plastics Digest

(From pp. 56, 58)

lication of the article describing this rapid, reproducible, and versatile means for measuring the abrasion resistance of organic as well as several other coatings.

Selecting package cushioning. R. K. Stern. Modern Packaging 33, 138-45, 197 (Dec. 1959). A method for determining shock isolation characteristics of dynamic cushioning tests is described. The method is applicable to a wide variety of materials, including plastics foams, and is useful in helping to select suitable materials for specific applications.

The thermal incline as an evaluation tool in fluidized bed coating. C. J. Metz. SPE J. *15*, 1064-65 (Dec. 1959). A method is described for use of the thermal incline apparatus in evaluating coating materials for fluidized bed operations. A description is given of the method that is used in measuring flow values at various temperatures.

Quantitative analysis of ethylene-propylene copolymers by the mass spectra of their pyrolyzates. E. Bua and P. Manaresi. Anal. Chem. *31*, 2022-24 (Dec. 1959). A standard pyrolysis method is used to determine the composition of copolymers of ethylene and propylene. The volatile products of the pyrolyzate are examined by mass spectrometric techniques. The method is said to be quantitative to ±2% of the copolymer composition.

Publishers' addresses

Analytical Chemistry: American Chemical Society, 1155 Sixteenth St., N. W., Washington 6, D. C.

ASTM Bulletin: American Society for Testing Materials, 1916 Race St., Philadelphia, Pa.

Chemical and Engineering News: American Chemical Society, 1155 Sixteenth St., N. W., Washington, D. C.

Chemical Week: McGraw-Hill Publishing Co. Inc., 330 W. 42nd St., New York 36, N. Y.

Down to Earth: Dow Chemical Co., Midland, Mich.

Journal of Chemical Physics: American Institute of Physics, 57 E. 55th St., New York 22, N. Y.

Journal of Polymer Science: Interscience Publishers Inc., 250 Fifth Ave., New York 1, N. Y.

Kunststoffe: Karl Hanser Verlag, Leonard-Eck-Strasse 7, Munich 27, Germany.

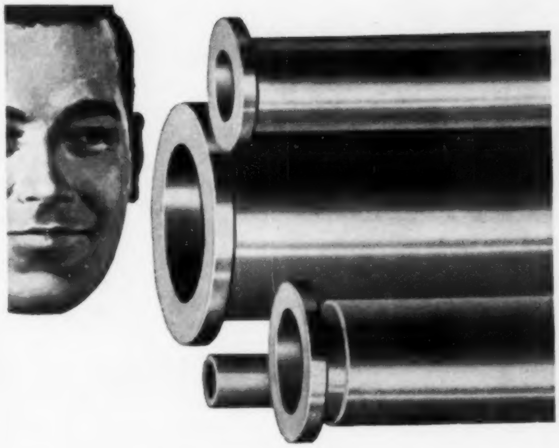
Materials in Design Engineering: Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.

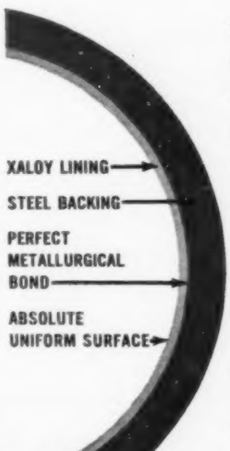
Modern Packaging: Modern Packaging Corp., 575 Madison Ave., New York 22, N. Y.

Plastics Institute Transactions & Journal: The Plastics Institute, 6 Mandeville Pl., London W1, England.

Space/Aeronautics: Conover-Mast Publications Inc., 205 E. 42nd St., New York 17, N. Y.

SPE Journal: Society of Plastics Engineers Inc., 65 Prospect St., Stamford, Conn.—End

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Boom ahead

(From pp. 87-91)

But much of the future business in expandable polystyrene moldings does not require such elaborate equipment. Undoubtedly, many companies will be able to start in a modest way with relatively small investments. It is generally felt that sufficient capital should be available for the installation of six presses within a short time—some molders now operate up to 120 presses and do a volume of about $125,000 a month—so that around $70,000 would represent an average minimum initial investment.

Applications and markets

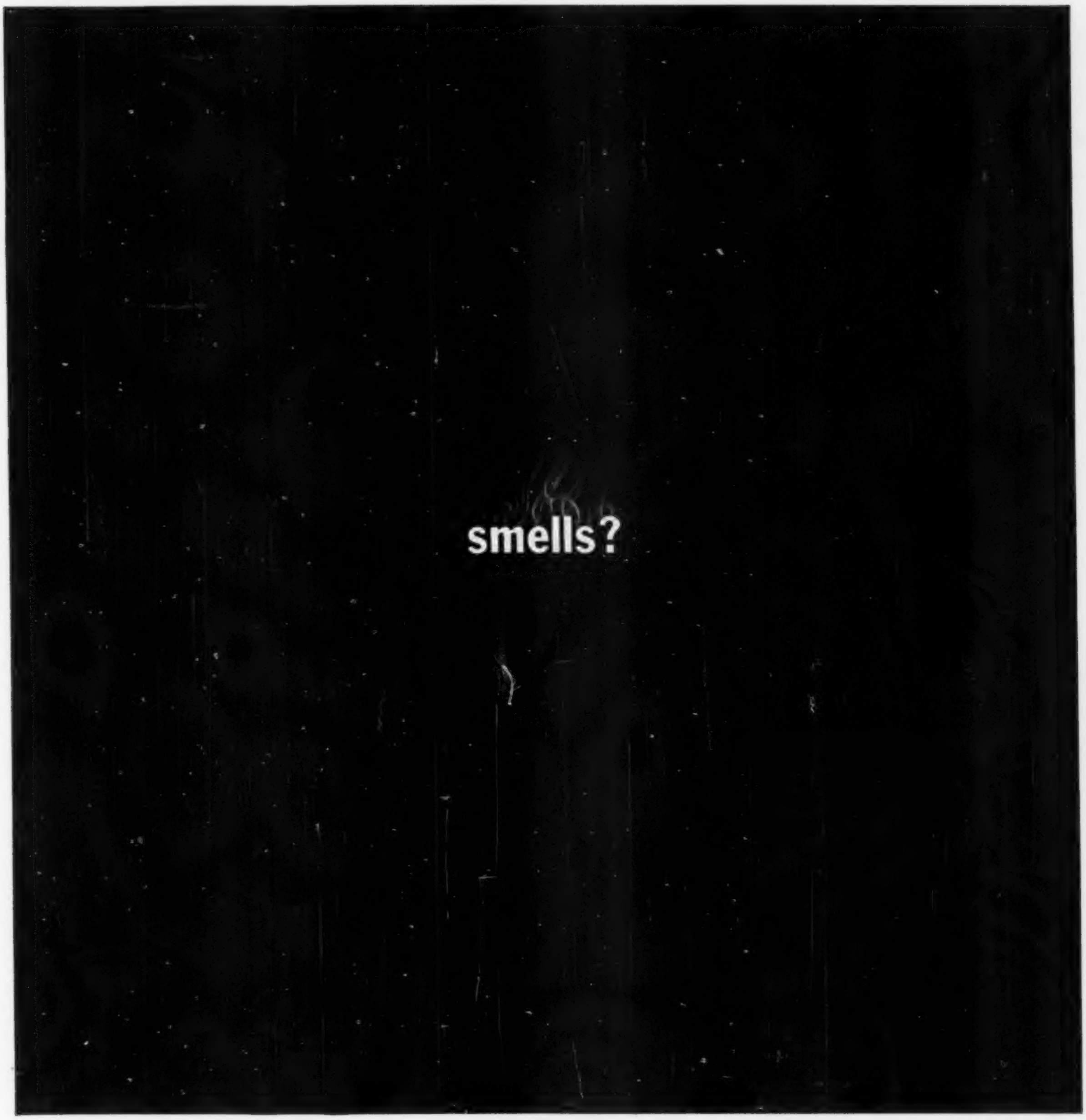
About five years ago, expandable styrene foam found limited markets in such fields as insulation, flotation, containers, furniture, and packaging. Reports on these developments have been published in MODERN PLASTICS and are summarized on p. 193.

Now we are at the point of breakthrough. In the next few months, bigger pieces and much larger volume uses will spring up in all major fields of application. Here are some examples: An 11-ft.-long boat with a 38-in. beam molded in one piece, with the hull weighing 30 lb., capable of supporting 500 lb., is produced by Worcester Moulded Plastics Co. and marketed by Snark Products Inc., New York, N. Y. Called the Sea Snark, it sells for $99.75. The sail is made of Koppers' Durethene 5-mil-thick PE film. Another marine use, supplied by Gilman Brothers, is molded flame resistant inner cores, coated with epoxy resins, for use in lifeboats.

The cooler and ice bucket market is expected to consume 5 million lb. of beads in 1960. In the pipe insulation field, T's, unions, and elbows complement the molded pipe jackets.

In air conditioners, current uses include the insulating base and drain pan. Worcester supplies a 4 lb./cu. ft. density tray that costs less than a molded tray made from thermoplastic materials.

Really exciting possibilities are opening up in the packaging field, where molded expandable polystyrene foam has proved cheaper



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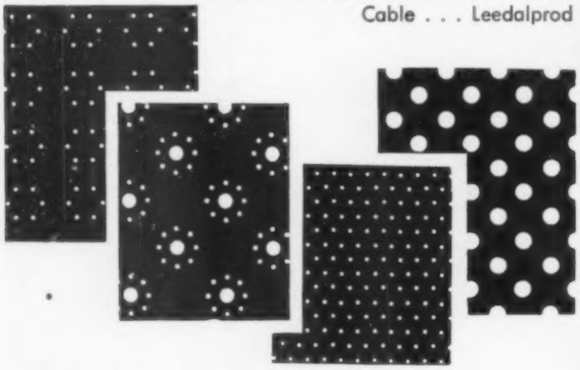

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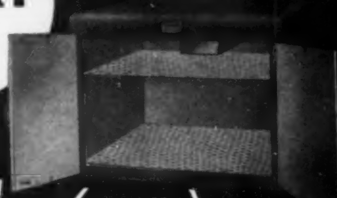

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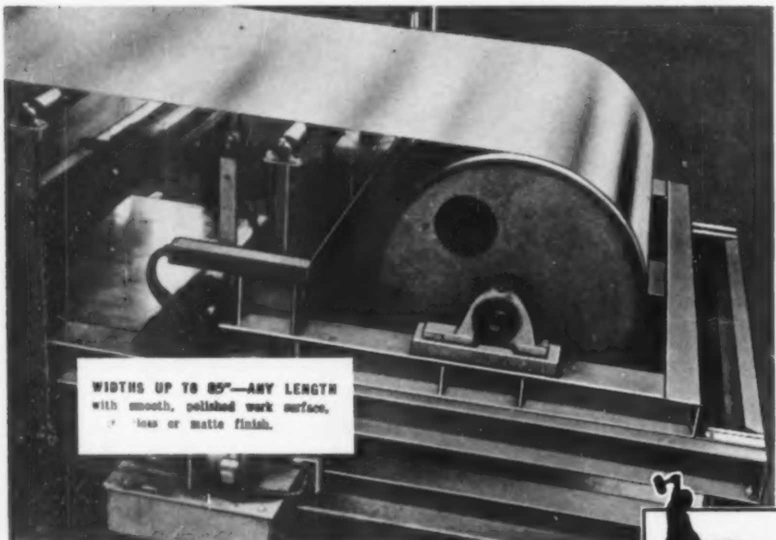

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than paperboard and glass jars. Chas. Pfizer & Co. Inc., Brooklyn, N. Y., is using foam in sample mailers, which often go into thousands of units. In some cases, the platforms are designed in three sizes to cover the company's various mailings of vials and catch covers, and to permit the use of a standard size mailer by merely changing the platform. Many die-cut paperboard parts were eliminated, neater packages and better protection of fragile items was possible, and savings in labor costs offset the higher cost of the foam material. Foampak Corp., Philadelphia, Pa., supplies Pfizer's wide range of molded foam platforms.

The same ingenuity in making basic units serve the packaging needs for a variety of different size containers is shown by The A. C. Gilbert Co., New Haven, Conn., who use five basic tiers to hold miniature apothecary jars in 10 sets of children's chemistry sets. The company has also developed more compact protective packages for its microscopes and accessories, which have merchandising and display appeal and provide quality connotations appropriate to the company's scientific kits. In Gilbert's Erector sets, molded platforms eliminated 19 laborious pinning operations previously required to keep the contents in place during shipment. These packaging items for Gilbert's broad range of educational children's kits—molded by Sullifoam Products Co., Willowgrove, Pa. and Worcester Moulded Plastics—saved about 5% waste caused by cardboard inserts which were torn during assembly operation.

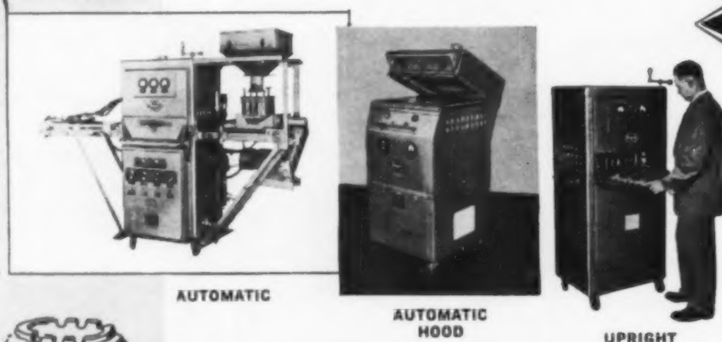
Standardization of camera housings and careful mold design enable Bell & Howell to use three molds for 12 different camera models, although each foam part is fitted exactly to the product. These parts, molded by Glo-Brite Foam Plastics Products, Chicago, Ill., virtually eliminated damage in shipment and handling; cut packaging labor costs by about 50%; reduced the weight of the package by about 25%; and eliminated the use of the conventional paperboard folding carton or set-up box. General Electric Co. found that foam platforms molded by Duval Industries, Winthrop,

Mass., for shipping lightmeter mechanisms, were less expensive than injection molded containers; had more rigidity and lower cost than vacuum formed items; and less weight, no moisture content, and more resilience than wood. Because of the convenient size and configuration, the foam parts proved to be the most economical shipping method and they can also be used as in-plant pallets, or on the customer's workbenches.

For the first time, C. P. Clare & Co. Inc., Chicago, Ill., can guarantee that its delicate telephone relays will be in operating condition when unpacked, because molded expandable polystyrene foam end caps, designed by H. Honeycutt, Chicago packaging consultant, provide complete protection. Compared with die-cut corrugated and solid fiberboard innerpacks which were previously used, they also cut packaging material costs by 20%; reduced shipping cube by 15 and weight by 8 percent. They can be packed four times as fast and are unpacked twice as fast. Kalamazoo Plastics, Kalamazoo, Mich., and Illinois Molding & Mfg. Co., Chicago, Ill., mold these caps to a tolerance of ± 0.005 in., with cavities that do not contact the relays at points where they could cause damage.

An entirely new field for molded beads is about to be invaded by Colgate-Palmolive Co., who are considering replacing opal glass jars for one of their cosmetic creams with a foam jar, slightly larger than the 4-oz. glass counterpart; weighing approximately one-tenth as much; and costing 20% less. Sheffield Plastics Inc., Sheffield, Mass., who helped to attain the required mechanical strength for the threaded portion, and solved such other problems as proper lip design to avoid using a cap liner, has set up a separate container division to produce the jars and also other products in the large variety of contours that are possible through the molded foam technique.

Paper cones in high fidelity loudspeakers made by Electro-Voice Inc., Buchanan, Mich., have been replaced by expandable polystyrene, because they possess more rigidity and are light in



AUTOMATIC　AUTOMATIC HOOD　UPRIGHT

weight. Other rigid materials would have been too heavy for the 30-in. diameter cones. Foampak Corp., Philadelphia, Pa., and Robinson Industries, Coleman, Mich., make precision-molded gaskets for phonograph and radio speakers, which are designed to replace die-cut pasteboard.

This foam has not made any impact in furniture cushioning because of its rigidity, but Gilman Brothers Co. and Plastifoam Corp. are molding the base for helicopter seats and backs, which are then covered with urethane foam.

Rayon-flocked molded novelty animal banks as premium or giveaway items, produced by La Della Plastics, Fox Lake, Wis.; tunnels for hobby railroad layouts molded by Life-Like Products Co., Baltimore, Md.; and bowling pins molded by Sullifoam for Aurora Plastics, West Hempstead, N. Y.; give an indication of toys that can be made from colored or white beads, or with decorative surfaces in a wide range of contours and sizes.

With expandable polystyrene foam products challenging billion-dollar-markets in packaging, insulation, and flotation, and consumer and proprietary items mushrooming, bead consumption for custom molded and proprietary products—other than blocks and sheets—is expected to grow from around 10 to 15 million lb. in 1960 to more than 40 million lb. within the next five years. Packaging alone will probably grow from its present two million lb. to five or six times that volume within three years. This growth will undoubtedly attract many companies that are now supplying competitive materials; and also large end users who will set up captive molding operations. But the custom molder with technical know-how, design ingenuity and a sound sales policy, will benefit by the growing acceptance of this material in established markets and in applications that will be developed as the cost saving possibilities and versatility of molded expandable polystyrene foam become more widely known.

This is the first in a series of articles. Subsequent issues will cover foaming of "logs," injection molding, extrusion, and blow molding of expandable polystyrene foam, and high frequency energy molding.

References

The following articles in earlier issues of MODERN PLASTICS discuss in more detail established applications for expandable polystyrene foam:

General

"Popcorn plastics," p. 103, May 1954; "Markets in the making for rigid foams," p. 124, Oct. 1957.

Insulation

"Plastics versus heat and cold," p. 87, Dec. 1954; "Molded expandable styrene containers," p. 106, Feb. 1956; "Expandable polystyrene minnow bucket," p. 197, June 1956; "Big cold box," p. 122, May 1957; "For portable refrigerators molded styrene foam takes over from metal," p. 93, May 1959; and "No sweat with foam jackets," p. 89, Feb. 1960.

Flotation

"Styrene foam float," p. 205, Nov. 1955; "Styrene foam float and life preserver ring," p. 219, April 1956; "Unsinkable boat," p. 112, Sept. 1958; "Marine markers with endurance," p. 111, March 1959; "Expandable polystyrene flotation toy," p. 158, Aug. 1959; "Portable island," p. 86, Oct. 1959.

Miscellaneous

"Expanded styrene novelties," p. 190, Dec. 1955; "Foamed styrene for flower pots," p. 106, Feb. 1956; "Jet age crash helmet," p. 88, Aug. 1957; "More about foamed polystyrene cups," p. 39, Sept. 1958; "Display shell," p. 190, Sept. 1958; "Foamed styrene cuts missile costs," p. 167, Nov. 1958; "Foam chair frame is 2/3 lighter, 5 times stronger," p. 98, April 1959; and "Crash cap for cops," p. 77, Aug. 1959.—End

Post office

(From pp. 92-94)

is based upon its clarity for full visibility, light weight, resistance to breakage, and ease of fabrication. Supplied by Cadillac Plastic & Chemical Co., Detroit, the ⅛-in. sheet stock was fabricated into 291 half-doors (each 2½ by 10 in.) used on the 12 keyboards. Also of Plexiglas, in translucent white, are the light shields for fluorescent tube lighting used on the back side of the machine, where the destination pockets are located. Total estimated poundage of acrylic sheet in the machine is 130 pounds.

The destination receptacles, from which sorted letters are removed manually as they become filled, have bottom liners injection molded from high-impact styrene material. The ribbed design of the liners (see close-up in photo, p. 92), supports the stack of letters in an elevated position, permitting the clerk's fingers to be slipped beneath them for quick as well as convenient removal.

For the 279 destination bins, the liners required about 140 lb. of styrene material. They were produced in the Plymouth, Mich. plant of Burroughs Corp., using styrene material supplied by The Dow Chemical Co.

Each of the 12 operator consoles includes 10 finger-fitting control keys which are depressed in proper combinations to sort each letter into its destination bin. Tops for these keys, injection molded of butyrate, are produced by Burroughs in the plastics department of its Plymouth plant. In the electrical circuitry of the letter sorter, liberal use has been made of a number of plastics, including phenolic and nylon, which were selected for both mechanical and electrical properties.

In view of the hundreds of pounds of plastics involved in each letter sorting machine, and the fact that the Post Office Department will probably be ordering this type of equipment in increasing quantities as part of its current mechanization program across the U. S., the semi-automatic letter sorter represents a rather important new outlet for plastics materials.—**End**

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MONOPLEX S-90E—applications requiring retention of resistivity, tensile strength, and elongation after long-term high-temperature aging (either dry, immersed in water, or exposed to high humidity).

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Chemicals for Industry

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION

Washington Square, Philadelphia 5, Pa.

Custom drawer

(From p. 95)

on a fully automatic Vacform 30-50, using 0.120-in. polystyrene sheet (Monsanto's Lustrex 88). The forming is a combination of male and female moldings. All of the three models are formed simultaneously using a three-cavity mold.

The formed sheet is trimmed in a specially designed shaper-jig to assure that the edge of the drawer is an arc (a straight edge on the sheet would cut into the finished edge of the case).

Quality standards are maintained at a high level. First, sheet thickness is high enough to overcome problems of cold-flow in long-term loading. And while precise data on cycle times is not available, processing conditions are designed to give a high-quality product. Robert A. Schless Jr., who is president of the processing company, made the following observations:

"In our cycling, we attempt as much as possible to pre-stress the drawer against load. This, again, is because the material has not been on the market long enough to guarantee by actual usage its use over periods of, let us say, 20 years. Therefore, to minimize risk, we will not utilize techniques which might harmfully stress and ultimately weaken the product. I refer here to cooling, as well as heating, cycles."

The new special-use drawers, an outgrowth of ideas originally developed by Monsanto and Pratt Institute of Technology, were chosen by Richardson designer Lawrence Peabody for incorporation in some of his company's case good lines.

The original Monsanto-Pratt designs were modified by Schless in order to make them structurally stronger. This was principally achieved by forming the units with peripheral, uninterrupted beam sections.

The original job was run for Richardson Bros. as a custom order, with an expiration date of July 5, 1960. From that day on, Robert A. Schless & Co. Inc. will sell these drawers as a proprietary item to all users. Retail list price is approximately $4.—**End**

Vinyl fabrics

(From pp. 104-108)

involves highly volatile solvents, each unit is located in a separate room along the east outside wall and isolated from the other production processes by firewalls. The printing equipment includes two types made by Lembo, a special unit for printing or plastisol coating by Dilts, and a unit that is specially designed and built for Ford requirements.

The finished coated fabric is trucked to quality control stations, where operators using Progressive inspection equipment scan each roll 100% for visual defects as well as color matching against a master sample under simulated daylight illumination (Photo 8). Each coded roll of material is then held pending completion of physical and chemical tests to insure that it meets specifications.

Included in these checks are Weatherometer and Fadeometer tests, wear, tensile, creasing, and cold cracking tests at temperatures ranging down to −50° F., as well as others covering specific gravity, plasticizer migration, staining, gloss, color fidelity, etc. Accepted rolls are then loaded for delivery to Ford's Highland Park, Mich., plant and supplier plants where the material is converted into finished trim items by cutting, sewing, heat sealing, etc.

In the plant's extrusion department, approximately 50 vinyl welting items are produced. Two NRM extruders—a 2½-in. unit and a 3½-in. model—are used in this department (Photo 9). The two shapes made have a 1/8- and 3/16-in. bead. They are used where sewed seams are required. Upon emerging from the extrusion dies, the still impressionable welting passes over a patterned roller which gives it a surface matching that of the trim stock. For this operation, Ford compounds its own vinyl material and prepares the cubes to a matching color.

Due to the high degree of equipment integration in the Mt. Clemens plant, average production quality is very high and scrap losses are small. Practically the entire output of the plant is sold to Ford Motor Co. at prices which must be competitive.—**End**

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Polyester-steel

(From p. 109)

reportedly shown 10 times more abrasion resistance than materials presently used for counter tops. It is also said to be unaffected by most acids and other chemicals, oxygen, and industrial fumes. Service temperatures are in the range from —40 to over 200° F. The strip is presently produced in widths up to 48 inches. National Steel looks toward a volume of 1500 running ft./min. (of various widths), three 8-hr. shifts per day.

How the coil is produced

After the steel coil has been thoroughly cleaned, it goes through a composite two-unit oven at a curing temperature of 300 to 600° F. Prior to this "curing," two applicators have deposited preheated plastic coatings to both sides of the metal. A proprietary adhesive is applied on the decorative side, while the reverse side gets a protective or decorative coating, depending on customer specifications.

As the coil comes from the dual oven, the protective coating on the reverse side has been cured. The adhesive-type coating on the decorative side is "tacky" in preparation for the application of a polyester decorative film. This film is fed from immediately below the dual oven to pressure rolls.

The decorative film, supplied by Di-Noc Chemical Arts Inc., is a non-oriented polyester formulation based on a Goodyear resin tradenamed Vitel, and is of the same family as Goodyear's extruded Videne film. To produce the film, Di-Noc casts the resin on a dry-strip backing paper.

As soon as the continuous coil leaves the pressure roller which has applied the film, it passes into the cooling section. Here, the metal, from a temperature of about 350° F. or higher, is "shocked" to a temperature just below freezing to produce the right degree of bond and set.

The development is still in its infancy and meaningful volume figures are not available. National Steel, however, reports lively end user interest and anticipates sizable volumes to be consumed by many industries.—**End**

High-clarity blown film

(From pp. 115-118)

made while operating only with a high (20 in.) frost line (See Table V, p. 118). The high frost line did improve optical properties, but to a much lesser degree than the annealing chamber. In the case of Petrothene 201, transmittance was increased from 39 to 52% by raising the frost line 12 inches. Adding an 8-in. annealing chamber and using a 1-sec. retention time increased transmittance to 70 percent. Other optical properties were similarly improved, with little or no change in physical properties of the film. Extrusion conditions and melt temperatures were identical for all trial runs.

Since the polymer is in the melt stage for a considerably longer length of time when the annealing chamber is used, control of the haul-off variables must be stringent in order to minimize wrinkles. Alignment of the die, nip rolls and forming canopy is critical, as is gage control.

The air ring should be constructed so that the cooling air impinges against the film surface at approximately a 30° angle. There should be sufficient clearance between the bubble and the air ring orifice so the force of the air impinging against the bubble does not cause the bubble to vibrate. As is the case without a chamber, the film must be sufficiently cooled before it passes through the nip rolls. Otherwise, the film may be damaged and its properties adversely affected.

In the studies reported here, blocking was observed to be significantly increased when using the annealing chamber, due to the reduction in cooling time available. For the equipment used, the distance between the die face and nip rolls was 7.5 feet. Using the chamber raised the frost line and decreased the cooling distance to only 4 to 5 ft. between the nip rolls and the air ring orifice. By increasing the slip concentration, blocking was almost eliminated. Therefore, it is felt blocking can be completely eliminated with the use of a higher take-off canopy and, if necessary, the use of antiblock agents and higher slip formulations.—**End**

Design tips

(From pp. 130-135)

is best to select an edge geometry that will provide the maximum rigidity comparable with esthetics and function. This phase of design is important where the edge is straight or where it must "mate" with another component; for example, a rectangular box and lid. Figure 9, p. 135, illustrates lip design features that can be employed to increase the rigidity of this section. Figure 10, p. 135, is a photograph showing items with these designs. The part at the extreme right of the photograph uses the same turned lip design of the center bowls in reverse.

General design

In addition to features that are desirable from the standpoints of rigidity and freedom from distortion, there are several other important aspects of polyolefin item design. As with other materials, extreme or abrupt variations in wall thickness and sharp corners that might serve as points for stress concentration should be avoided if at all possible.

Gussets and ribs should usually be no greater than 50 to 80% of adjoining wall sections and, where possible, should be avoided altogether. Excessively heavy ribs can cause objectionable sink marks and distortion of adjoining walls, thereby spoiling the appearance of the part.

Of particular importance in designing polyolefin items is the gate area. This section should be thick enough to allow rapid filling and minimize orientation. It is usually advisable to make the gate section of large items up to 25% thicker than other areas. This improves the ease of fill, prevents excessive cooling of resin flowing to extremities and results in improved impact strength. The thickness at this point can, of course, be carried to the extreme causing jetting and excessive shrinkage, which may take place under such conditions.

Where possible, it is desirable to gate into a dome or other expansion feature of the types illustrated in Fig. 11, p. 135, thereby permitting some relief of molded-in stress which occurs here.

The importance of the surface appearance of molded consumer items cannot be over emphasized. With most grades of polyolefin resins it is possible to accurately reproduce the mold surface. A high gloss or attractive "three dimensional" texture can be readily achieved. However, the luxurious appearance and excellent mar resistance imparted by use of a "pebble-grain" or other "three dimensional" surface texture is just beginning to be realized. This type of surface virtually eliminates the possibility of "flow marks," weld lines, and other undesirable surface imperfections.

As shown in the figures and verified by the experience of many molders, an item that might otherwise be difficult to produce from polyolefins can often be greatly improved and made easier to produce with high quality by using proper part design principles. Proper design may also reduce costs by eliminating rejects.—**End**

RP structures

(From pp. 120-128)

is incorrect since the resin has a finite modulus of rigidity.

Many physical properties of fibrous glass must be investigated in order to determine their effect on the strength of a laminate. The effect of resin content, resin shear and tensile strengths, resin shrinkage, and surface finish need be evaluated. Work has been performed by the Forest Products Laboratory and the Wright Air Development Center, U. S. Air Force, to determine the effect of material variables on the strength of such laminates. However, additional basic studies as well as design correlation of the results are required (2).

Tests to determine basic material properties should be reevaluated with particular reference to specimen thickness. Some experimental data obtained from tension and compression tests have been published (11) but more recent tension tests at Grumman Aircraft Engineering Corp. indicate a need for additional testing and evaluation.

Experimental data: The majority of existing experimental data is from tests performed by the Forest Products Laboratory (2-8). Figure 6, p. 127, shows the results of tension tests performed on two of the following widely used glass fabrics, each supported by a high-temperature-setting, low-viscosity polyester resin (6). Type 181 fabric is approximately crossplied, and Type 143 fabric has a 9:1 ratio of warp-to-fill strength. Also shown in Fig. 6 are the computed values of tensile strength based on the theory. Agreement between tests and theory is very good, as illustrated in the plots that are shown in Fig. 6.

Tension tests were performed on two different laminates composed of the above fabrics and resin (3). The panel in Test 1 consisted of 13 layers of Type 143 fabric; 9 layers were oriented with their warp direction parallel to the axis of reference, 2 layers were oriented 40° from the axis of reference, and 2 layers were oriented 70° from the axis of reference. For the panel in Test 2, three layers of Type 162 fabric

were oriented with their warp direction parallel to the axis of reference, four layers of Type 143 fabric were oriented 170° from the axis of reference, and five layers of Type 181 fabric were oriented 40° from the axis of reference. The panels were loaded in tension at various angles to the axis of reference. The experimental and theoretical results are shown in Fig. 7, p. 128; agreement is unusually good.

The system in use

The mathematical procedure presented in this paper has been programmed for the IBM 704 computer at Grumman. A program has been initiated to obtain design curves for predicting optimum layer orientation in a laminate subjected to axial and shear loads in the plane of the laminate. Several widely used types of glass fabric are being tested in order to obtain basic material properties. Future work will include the testing of single fabric and multiple fabric laminates together with various layer orientations and a comparison with the theory.

The theory is being extended to include filament wound cylindrical structures, and optimum winding patterns are being investigated. A test program is in progress at the present time.

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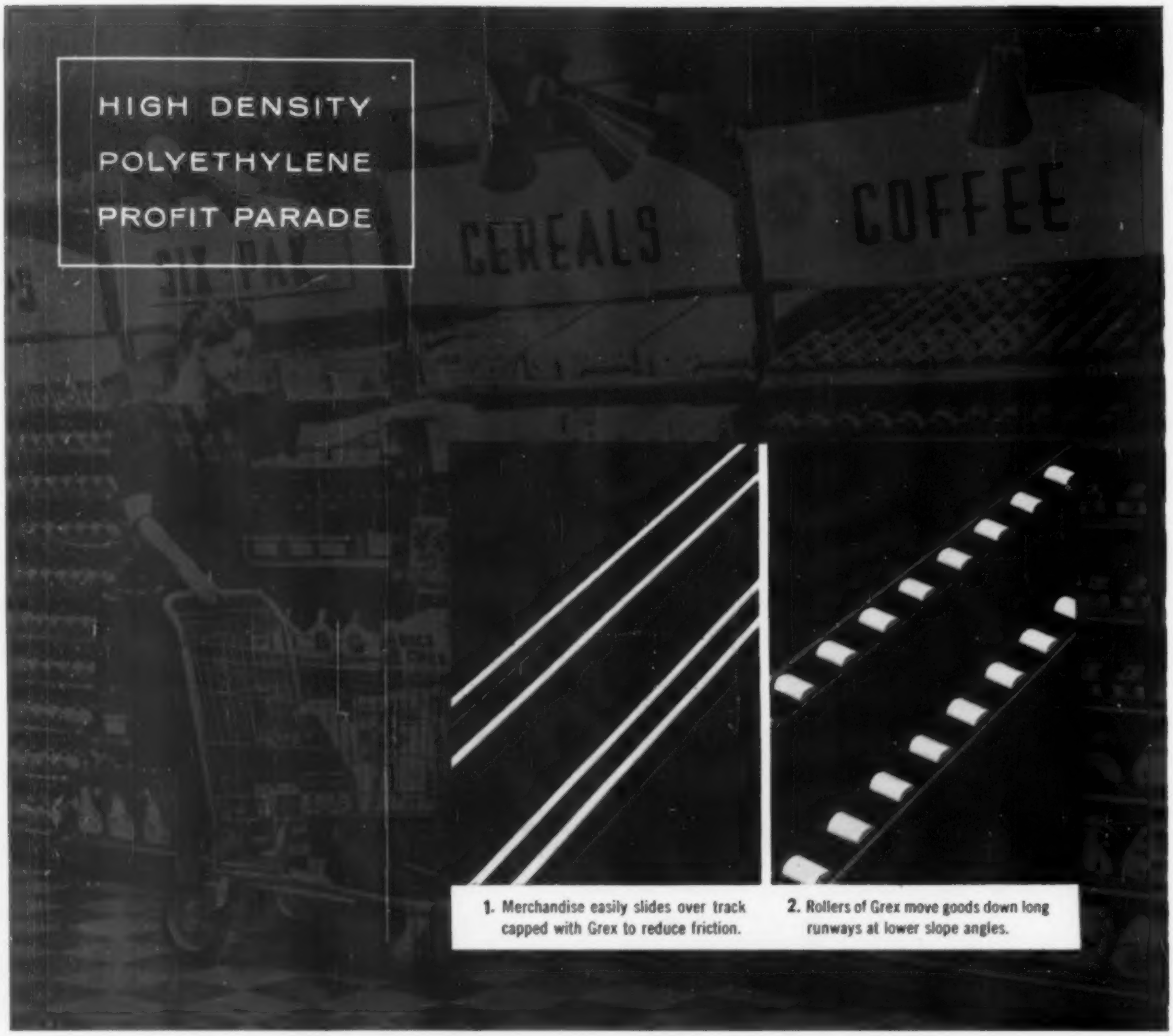

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Permeability

(From pp. 139-145)

described in a previous paper (3). A constant pressure of vapor was maintained over the film by using a supply of degassed liquid water or methanol at the appropriate temperature. The vapor pressure was measured with a Zimmerli gage. Figure 1, p. 139, shows the effect of temperature on the water vapor permeability of the homopolymer, plasticized homopolymer, and the Kel-F 500 copolymer. It can be seen that after keeping the latter at a high temperature, there was a marked drop in the permeability constant, which was presumably due to further crystallization.

Furthermore, there is an inflection in the Arrhenius plots, similar to those found with other polymers (3, 6), when passing through the glass temperature and the inflection point can be similarly interpreted. This would lead to a glass temperature of about 75° C. for the "amorphous" homopolymer. Attempts were made to determine the glass temperature with other gases.

Figure 2, p. 145, demonstrates a similar plot with carbon dioxide. Here there is only a slight inflection, indicating a glass temperature of about 50° C. This is closer to the value of 52° C. found by Hoffman and Weeks using the specific volume method (10). The higher values found with water vapor could be due to the larger size of diffusing species; this could indicate the movement of water vapor through the hydrophobic film in the form of clusters, as suggested by Rouse (11).

The Kel-F 500 films are internally plasticized by a small degree of copolymerization and the Kel-F 300P25 films are plasticized externally by the addition of low molecular weight Kel-F as plasticizer. Both of these treatments, as would be anticipated from the gas data, lead to a marked increase in the water vapor permeability constants.

Data for the methanol permeabilities of Kel-F 300 homopolymer and Kel-F 500 copolymer are given in Fig. 3, p. 145. The phenomenon of irreversible lowering of the permeability at higher temperatures is again shown and is presumably due to further crystallization of the polymer as it is "annealed" during the measurements at higher temperature.

The methanol permeabilities are much higher for the "amorphous" homopolymer than for the Kel-F 500 copolymer. This may be due to the low crystallinity leading to a greater solubility in the former case. With organic polymers solubility plays a much more important role than with the gases in determining the size of the permeability constant.

Typical permeability values for polychlorofluoroethylene films and other polymer films to the common gases and to water vapor are given in Table VII, p. 145. It can be seen from these data that Kel-F films provide exceptional gas and water vapor resistance.

We would like to thank the M. W. Kellogg Co. for sponsoring this study and providing the samples of the various films and the data concerning them. The Kel-F Div. of the company has since been absorbed by the Minnesota Mining & Mfg. Co.

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Determination

(*From pp. 156-160*)

Eq. 7. Four sets of experimental results appear in Fig. 1, p. 156.

A preferred method of solution, when sufficient points are available, is to fit the experimental data to a straight line by means of the statistical least-square approach. A step-by-step solution has been worked out for local use by a laboratary assistant. Confidence limits on the fit are obtained and are interpreted as a measure of variations in cell structure within the specimen.

Evaluation of method

The method described has been in regular use as a tool in studies of formulation and processing variables for about one year. Results have been valuable in understanding some effects of structure on the properties of rigid polyether urethane foams.

It has been established that the 90% confidence limits on Vg, for the apparatus and techniques described, are as low as 10^{-3} cc. This is taken as the basic level of experimental error; larger limits represent nonuniformity of cell size within the specimen.

When attempts were made to estimate the accuracy of the displacement method by comparison with microscopic studies (Table I, p. 158) reasonable agreement was obtained. It was, in fact, concluded from this experience that the displacement method is the better of the two because of the difficulty in 1) converting linear microscopic dimensions of the polyhedral cells to volumes, 2) obtaining accurate dimensions of cells inclined from the plane of microscopic focus, and 3) studying representatively large samples under the microscope. The displacement approach is obviously more economical and more adaptable to routine usage.

The desirability of the present method for determinations of open cell content is illustrated in Table II, p. 158. It is clear that individual R & P results are sensitive to specimen dimensions and should always be reported at some standard *R*, agreed on by all interested parties. This difficulty is solved automatically when *F* is

reported. It may also be pointed out that, when Eq. 7 has been solved for a foam, the effective open cell content of that material may be estimated for any application involving exposed surfaces.

Application of results

It is probably true that the main reason for the lack of quantitive information concerning the effects of cell structure on foam properties is the need for a convenient means of describing this variable accurately. That such a technique is useful may be illustrated by a few general examples taken from the experience of this laboratory.

In one case a rigid polyether urethane foam was prepared in adjustable molds with opposite walls spaced to provide 2 to 8 in. of foam thickness in 1 in. increments. Reactants were foamed through a machine at each of two rotor speeds. At mixing speed *A*, Vg was 0.0002 cc., while at speed *B*, Vg was 0.0011 cc., regardless of mold dimensions. The volume fraction of open cells was constant at 0.02 for all molds and both mixer speeds. All foamed products developed identical mechanical properties.

A second series of polyether foams was employed in an inquiry into cell nucleation. The presence of air in a foam is known to reduce cell size, and theoretically a dispersed crystalline solid should do the same. With no air a certain product developed a coarse, open structure; Vg was 0.0150 cc. and *F* was 0.13. When 5 to 25 vol.-% of air was whipped into the liquid reactants, Vg and *F* were reduced to 0.0015 and 0.015, respectively. Mechanical properties and density of the latter products averaged the same as the former, but showed improved reproducibility. Dimensional stability of the open-celled product was nearly perfect, whereas the fine-celled material swelled during extended exposure to 100% relative humidity at 70° C.

When 1 volume % of a crystalline solid was added to the same liquid foam ingredients, with no air, Vg and *F* were found to be 0.0040 cc. and 0.025. When air and the solid were used jointly, Vg and *F* were about 0.0007 cc. and 0.000, respectively. In spite of these latter changes in structure, mechanical properties continued reproducible and unchanged; dimensional stability improved in the presence of the solid.

A number of additional examples could be presented showing effects of cell structure on the heat and mass transfer characteristics of foams. With sufficient information of this type, it becomes possible to distinguish between effects caused by the organic and by the surface chemistry of a foam system. It is then practical to achieve desired properties by deliberate control of structure.

Acknowledgments

The assistance of R. L. Rollins in performing calculations, and of E. L. Buster and J. H. Parsons in operating the local apparatus and improving techniques is appreciated. The assistance of personnel of Union Carbide Chemicals Co. in preparing this data for publication is gratefully received.—**End**

THE PLASTISCOPE*

News and interpretations of the news

By R. L. Van Boskirk

Section 2 *(Section 1 starts on p. 41)*

June 1960

New high-impact styrene

Development of two new high-impact polystyrene resins with improved toughness characteristics has been announced by The Dow Chemical Co. They are designated Styron 475B and 475C.

Styron 475B is an extrusion resin for making sheet used in thermoforming; 475C is a molding grade designed for use in most molding applications, especially thin section parts or those where long flow areas are encountered. Applications for the new materials include refrigerator door liners, formed cheese containers, and small appliance parts. The two new resins are priced the same as Styron 475 at 28½¢/lb. For special colors, the price is 32½¢ per pound.

PVC film for records

A new high-strength grade of unplasticized vinyl film and sheeting possessing properties especially suitable for the manufacture of low-cost advertising and educational phonograph records has been announced by Monsanto Chemical Co.'s Plastics Div. Trademarked Ultron R-501, it is available in thicknesses from 0.004 to 0.020 inch. The thin pliable vinyl permits the record to be stapled or stitched in magazines and books without special equipment, the company states. For mailings, the unbreakable records can be sent flat or can be easily rolled up for cylindrical tubes. Reported to have high fidelity, the records can be replayed hundreds of times and can be made from several colors of Ultron material in transcription speeds ranging from 33 to 78 r.p.m. For other uses such as wall coverings, flooring, maps, displays, luggage, lamp shades, and vinyl metal laminates, the new material can be vacuum formed at normal temperatures, and can be printed on lithograph, letterpress, and rotogravure equipment with excellent results, Monsanto states.

New polypropylene film bids for cellophane markets

The overwrapping market, now dominated by cellophane, is the main target of Kordite 1500, a heat-sealable biaxially oriented polypropylene packaging film developed by The Kordite Co., Div. of National Distillers & Chemical Corp., Macedon, N. Y. Unlike other thermoplastic films, the new material is claimed to operate well on most existing automatic packaging machines and the company claims that Kordite 1500 can be used for overwrapping textiles, cigarettes, chewing gum, candy, and consumer products requiring moisture protection.

According to Kordite, ½-mil thickness of the new film provides the same protection as 1-mil thick cellophane, and since Kordite 1500 has two-thirds the density of cellophane, the PP film is said to be cheaper. Normal coverage of 1-mil cellophane is said to be about 20,000 sq. in./lb., compared with 50,000 sq. in./lb. of the new material. The introductory price of the new material in ½-mil thickness is 3½¢ per 1000 sq. in., and the company claims that the eventual price may go down to 1½¢ per 1000 sq. in. Basically, the new film is like cellophane in strength (20,000 to 40,000 p.s.i.), stiffness, clarity, grease-resistance, and handling properties; and like polyethylene in moisture properties, and dimensional stability irrespective of humidity changes, the company claims.

The improved properties of the new material are due to the biaxial orientation which, in the case of polypropylene, increases strength and stiffness by about four times. It also improves optical properties and eliminates low temperature brittleness associated with unoriented polypropylene. However, Kordite points out that, although its film is biaxially oriented, its mechanical properties are not the same in both directions. Kordite 1500 has a special coating to improve its heat sealability. Oriented films can be heat sealed, but they disorient during the heat sealing process and may cause puckered or weak seals.

The coating also allows the seals to be peeled apart, thus facilitating opening of a package. Biaxially oriented film without the coating is also available for evaluation and is called Kordite 1000. This material is expected to find markets in produce packaging and for window envelopes.

PP fiber resists sun

Development of a polypropylene fiber that is said to resist the effects of sunlight has been announced by United States Rubber Co. The fiber, developed chiefly for outdoor furniture webbing, has been made part of the company's line of synthetic fibers and is known as Royalene UF.

Laboratory and Florida sun tests reportedly indicate excellent performance of the fiber for a period of more than four years. In addition, the fiber has greater initial tensile strength and can be made in brighter colors than other sun-resistant synthetic fibers now available, according to the company. The sun-resistant feature is attained by using a highly stabilized PP resin in conjunction with a special process developed by the company's research division.

PE for pipe

Polyethylene formulations which are said to yield pipe at fast production rates with smooth, glossy surfaces both inside and outside have been made available by Eastman Chemical Products Inc., subsidiary of East- **(To page 216)**

* Reg. U.S. Pat. Off.

(From page 214)

man Kodak Co. The two new formulations are said to meet the requirements for Type II and Type III polyethylene pipe, respectively, as defined in the proposed revision of the commercial standard CS 197-59. According to the company, pipe extruded from both materials has passed the 1000-hr. sustained pressure tests at both 73° and 100° F., the incremental pressure test, the environmental stress-cracking test, and the field pressure test.

The Type II formulation, Tenite Polyethylene 2521E-60099, has a density of 0.939 and is priced at 35¢/lb. The Type III formulation, Tenite Polyethylene 2811E-80010, has a density of 0.950 and is priced at 38¢/lb. The National Sanitation Foundation has tested and approved both materials for the production of pipe suitable for transmission of potable water, the company states.

More PE film

Start-up of Dow Chemical Co.'s polyethylene film plants at Findlay, Ohio, and Fresno, Calif., sets the stage for greatly expanded distribution of this material by Dow and its Dobeckmun Co. Division. Trademarked Polyfilm, the film is produced in thicknesses from ½ to 10 mils in a variety of widths for flexible packaging, building, agriculture, and other industrial uses.

According to Dr. W. C. Goggin, manager of the Dow Plastics Dept., available industry estimates indicate that the total market for PE film will soar to approximately 650 million lb. annually by 1965—more than double the 1959 figure.

Facilities at Findlay occupy 208,000 sq. ft. of a 42-acre site. The manager is Robert W. Van Sickle, who formerly headed Dow Plastics Technical Service operations at Freeport, Texas. At Fresno, the new plant and equipment occupy four acres of a 24-acre site. Film manufacturing formerly done by Extruders Inc., a Dow subsidiary near Los Angeles, Calif., has been transferred to the new plant. The manager is William B. Sander, former president of Extruders Inc. Dow is using four established sales forces for the marketing of Polyfilm: to flexible packaging converters by the company's Film Sales staff; to end users in general industry by the Dobeckmun Co. Div. Sales; to the builder by Dow's Building Products Sales; and to the farmer by the company's Agricultural Chemicals Sales.

High-density PE compounds

An improved high-density polyethylene compound for wire and cable applications has been introduced by Union Carbide Plastics Co. Designated Bakelite DGD-4100, the new formulation is said to combine greater toughness, high abrasion resistance, reduced compressibility, and better heat deflection with greatly improved resistance to stress cracking and thermal embrittlement. In standard IPCEA (Insulated Power Cable Engineers Assn.) tree wire tests, the new material is said to have withstood over 1,500,000 cycles—reportedly 50% better than other high density PE tested.

DGD-4100 has been approved as insulation for military telephone singles, as insulation for single-pair (C-Rural) telephone distribution cable, and as insulation for aerial spacer cable and tree wire, according to the company. The new formulation is also being used in service drop cable, line wire, coaxial cable, and high voltage power cable.

For pipe. Union Carbide Plastics Co. has also introduced a new high-density PE pipe extrusion compound, designated DGDA-2033 Black 4865. It is said to offer good long term stress properties, coupled with easy processibility in conventional equipment at high extrusion rates. This material is designed to meet the requirements of Type III pipe, Series 2 (75 p.s.i.) and Series 3 (100 p.s.i.) under the proposed revision of Commercial Standard 197-59, and is said to carry the NSF seal of approval. According to the company, DGDA-2033 will enable pipe fabricators to extrude thinner wall pipe than with low- or medium-density polyethylene, while, at the same time, meeting the long term pressure requirements.

Phenolic shell molding resin

A new stable novolac resin developed especially for hot-processed sand coating is now available from Union Carbide Plastics Co., Div. of Union Carbide Corp. The new material, Bakelite phenolic resin BRR-7151, is said to have superior hot strength which allows faster cures and freedom from shell warping or cracking. Melt viscosities of the resin are said to provide good flow for higher shell or core strength. The resin is suitable for all types of hot coating equipment, the company states.

Uscolite slab stock

The mechanical goods division of United States Rubber Co. has announced several major additions to its line of ABS plastic slab stock, marketed under the tradename of Uscolite CP. The company is now offering fabricators 4-in. thick slab for the first time. This is the eleventh stock thickness offered by U. S. Rubber, the other 10 ranging in quarter-inch gradations from ¾-in. to 3 inches. At the same time, the availability of all of the 11 thicknesses in 12- by 12-in. stock slab was announced. Previously, only 36- by 36-in. slab was available as stock items with smaller slab sizes produced on special order.

Uscolite CP is an acrylonitrile-butadiene - styrene copolymer blend that is used for pipe, valves and fittings.

Phenolic molding compound

An asbestos reinforced phenolic molding compound produced by Rogers Corp., Rogers, Conn., and called RX-495, has reportedly been approved for applications under Government specification MIL-M-14F, Type MFI-20. It is claimed that the material can be used in automatic preforming equipment, and preheats well with electronic preheaters. It can be used on **(To page 218)**

THE PLASTISCOPE

(From page 216)

transfer and compression molds involving intricate details and is said to produce parts with very good appearance. Its characteristics include heat distortion temperature of over 500° F., molding shrinkage of less than 0.001/in./in., impact strength of 2.5 ft.-lb. (notched bar), and flexural strength of 12,000 p.s.i. RX-495 is being used in automotive and industrial gears, controls, and electrical switchgear, the company states.

Champion-Crown combination

After flirting with "plastics" for many years, Champion Paper & Fibre Co., Hamilton, Ohio, has now made definite moves in two directions. One was to obtain a license from Crown Machine & Tool Co., Fort Worth, Texas, to produce and distribute that company's famous Thermokups, which had been awarded a citation by the Plastics Industry for one of the year's most useful and unusual plastics products. The Champion license, obtained one year ago, includes distribution in all states except Texas and some bordering areas. Champion has now acquired Crown Plastic Cup Co., a former division of Crown Machine & Tool, for an undisclosed amount of Champion stock.

President of the new subsidiary is Charles G. Ellington, who is also president of Mid-West-Pak Corp., Belvidere, Ill., which manufactures Thermokups for Champion. J. H. Harrison, executive vice-president of Crown Machine & Tool and inventor of the cup, will remain as executive vice-president of the subsidiary, and W. M. Harrison will remain chairman. Mid-West-Pak doubled production recently and Fort Worth is again increasing its facilities.

The Thermokup was one of the first foamed bead polystyrene cups to attract widespread attention. It was used originally on airplanes for hot and cold beverage, and is now in demand almost beyond capacity production for use in in-plant feeding operations. Trade guesses on poundage of polystyrene beads used for this cup are several hundred thousand pounds a month.

The other move by Champion was to enter the field of plastic-coated papers and plastic films. Champion's entry into this field is a polyethylene coating with a surface treated by a special process. Regular inks printed by standard processes anchor firmly to this surface, gleam brightly and give a third dimensional appearance of depth.

While the advantages of plastic-coated paper and food boards have long been known in these areas, lack of really good printing and gluing surfaces has been a drawback, according to Champion, who feels that these problems have been solved by its process.

At its plant at Waynesville, N. C., Champion is installing equipment for plastic extrusion coating of its papers. The extruder portion of this equipment gives Champion the ability to extrude other present-day plastics such as high density polyethylene, nylon, polypropylene, Teflon, vinyls, polystyrene and other plastic resins. And new plastics still in the laboratory stage are within the range of this modern plastic converting equipment. With the coating portion, Champion can plastic-coat paper in widths up to 85 in. and with a controllable range of coating weights from 1⅓ to 24 lb. per 1000 sq. feet. The coating line can be operated at speeds up to 1000 ft. a minute. And large rolls, 85 in. wide and 84 in. in diameter, can be produced.

New secondary plasticizer

Lower formulating costs and good performance characteristics with vinyl compounds are said to be possible with a new secondary plasticizer which is available from Monsanto Chemical Co.'s Organic Chemicals Division. Called Santicizer 216, the new plasticizer offers formulators a low priced extender that is said to give good low-temperature flexibility, light stability, and low volatility to PVC plastisols and extrusions. It is commercially available at 9¢/lb. in bulk shipments of 2000 gal. or more, FOB Monsanto, Ill.

Epoxidized plasticizer

A newly developed epoxidation process for the production of vinyl plasticizers was licensed by Becco Chemical Div., Food Machinery & Chemical Corp., to Wilson-Martin, Chemical Div. of Wilson & Co., Inc., for 2 years, renewable for 2-year periods.

Wraps for laundry

According to a survey conducted by an independent market research company for U. S. Industrial Chemicals Co., manufacturer of Petrothene polyethylene resin, 72% of a 1300 member consumer panel prefer receiving their dry cleaning and laundry wrapped in PE film rather than other wraps. High on the list of reasons given by consumers for their preference of PE film wraps is transparency, said U.S.I. Closely following this is protection against dust and water, ease of storage, strength and better appearance than competitive packaging materials, according to the survey.

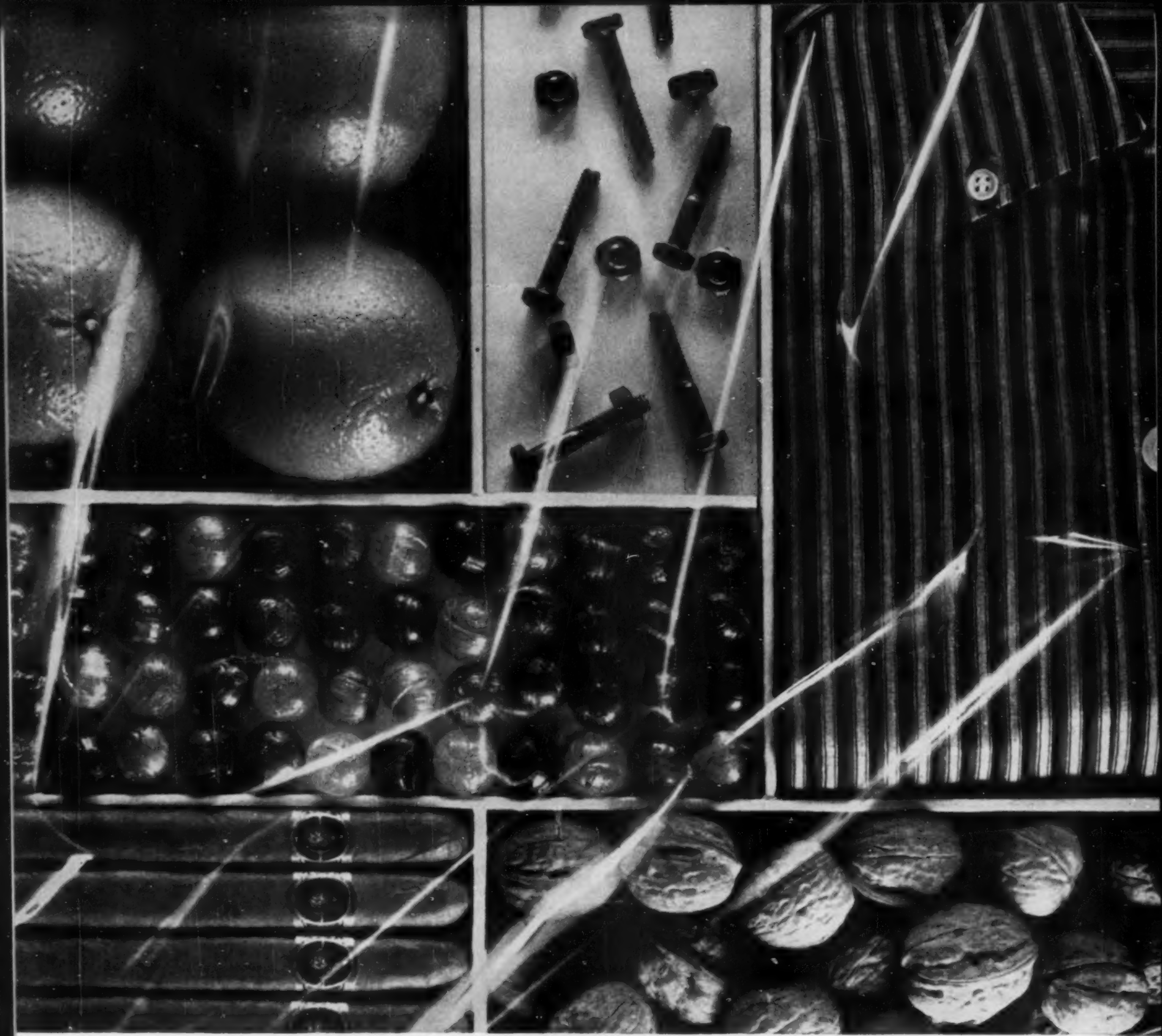
The panelists represent a cross section of consumers in 17 major cities coast to coast. In New York City alone, the preference for polyethylene is running better than 3 to 1. Chicago is over 7 to 1 and Los Angeles over 4 to 1.

The company further learned that 70% of those people, answering a mailed inquiry, reported receiving their dry cleaning and laundry in polyethylene. According to U.S.I. this indicates that the preference for PE by consumers is actually slightly greater than what is now offered by cleaners and launderers.

This type of demand is expected to result in an increase in the use of polyethylene by the dry cleaning and laundry industries, from the present consumption of 36 million lb. per year to 60 million lb. by 1965, U.S.I. states.

Glossy Kralastic

An easy-processing, high-gloss variety of its Kralastic ABS polymer blend has been announced by Naugatuck Chemical Div., U. S. Rubber Co., Naugatuck, Conn. The material, called **(To page 220)**



THE PLASTISCOPE

(From page 218)

Kralastic MH, was specifically developed for molded and sheet consumer products.

All of the conventional ABS properties have reportedly been retained in the new grade. But the composition of the new material has been modified so that it can be molded at the high speeds needed in consumer goods fabrication; and parts molded from the new material also have the gloss and decorative appearance required in this market. Among uses suggested by the company for the new material are housings and component parts for home appliances and business machines, automotive trim and hardware, women's shoe heels, radio cabinets, telephones, sporting goods, and small wheels.

Injection molding will be the major processing technique used with the new material. Tests are said to show that it can be molded at approximately the same molding speed range as cellulosics, impact styrenes, and polyolefins. The material is also easily vacuum formed and extruded, the company states. The new formulation can withstand exposure to temperatures up to 185° F.

Plastic smoke

The Dow Chemical Co. has acquired exclusive worldwide rights to commercial development of plastic smoke from the inventor, Miss Betty Lou Raskin, a research associate at The Johns Hopkins University Radiation Laboratory, Baltimore, Md. The smoke is made up of finely dispersed plastics particles. According to Dr. R. F. Boyer, director of plastics research for Dow, the company will continue research and development. Plans are still preliminary, but two general research possibilities are apparent: use as an artificial fog and recovery of small particles of plastics.

Low-cost chloro compounds

Free research quantities of new, low-cost chloro compounds with reactivity characteristics similar to benzyl chloride are being offered by International Minerals & Chemical Corp., Skokie, Ill. IMC foresees applications of the new compounds in plasticizers, adhesives, mastics, caulking compounds, lubricant additives, and many other fields.

The bis (chloromethyl) product, a low-cost bi-functional compound, is potentially useful in all types of polymers, according to the company. It can first be converted to glycol. The methylnaphthalene compounds are made with mixed methylnaphthalenes.

Stripper for organic coatings

A stripper for removing epoxies, acrylics, alkyds, and baked enamels from aluminum, and other metals has been developed by Esbec Corp., Stamford, Conn. Called Speedi-Strip #1010, it is the bond releasing type, and reportedly does not deteriorate. Once the bond is broken, the coating flushes off cleanly under a water spray, the company states. It is used at room temperature and is said to be non-flammable.

More colors for Micarta

The addition of 23 new colors and patterns to its Micarta line of decorative laminated surface materials has been announced by the Westinghouse Electric Corp. This brings the total to 64 colors. Like previous colors and patterns, they will be available from U. S. Plywood Corp., distributor of these decorative products in the United States. Increased contemporary interest in marble finishes has led to a new marble design in five colors. Another new pattern has traces of gold across some basic colors and additional wood grain colors include maple, cherry, walnut, rosewood, and mahogany.

Vinyl film for fabrics

Wall covering made of natural fibers and textured fabrics, genuine grass cloth, and slubbed linen is now protected against fading dirt, and other injury by a transparent layer of scrubbable vinyl film. Polyplastex United Inc., Union, N. J., manufacturers of the wall covering, has introduced its new Royaltex patterns, including designs utilizing genuine butterflies, leaves, and sea heather against simple textured backgrounds covered by a 0.004-in. layer of Union Carbide Plastics Co.'s Krene vinyl film which is laminated to the fabric.

Provides matte finishes

A new process that provides matte finishes on molded thermosets plastics has been developed by Norton Laboratories Inc., Lockport, N. Y.

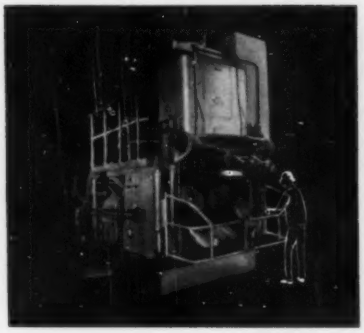
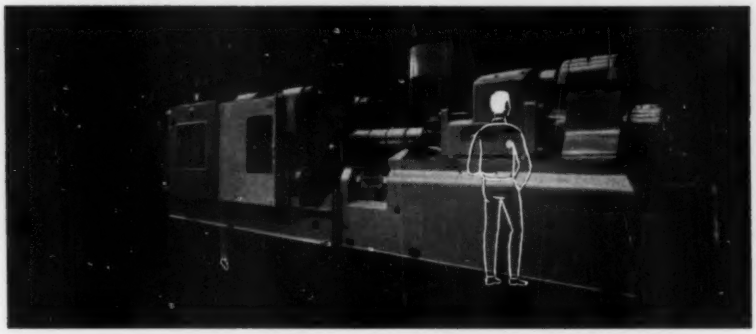
In the industrial field where non-glare is a desirable characteristic for instrument covers, matte-finish parts often can eliminate supplementary painting operation. Other applications include piano keys, knobs for lamps, and cameras, which require a non-glare, non-reflecting interior surface to avoid spoiling light-sensitive photographic film.

Clear coating for metals

A clear epoxy polyester coating designed for protection of both treated and non-treated decorative aluminum products and surfaces, as well as brass and other metals, is available from John L. Armitage & Co., Newark, N. J. The original luster of the base metal is reportedly retained with the use of the coating which is said to have a high degree of mar resistance as well as resistance to burns, cracking, and staining. The flexible epoxy is claimed to withstand a ⅛-in. bend. The coating can be applied by either spray or dip. It is baked for 3 to 15 min. at temperatures of 350° F.

Nylon bars to cost less

Price reductions up to 50% on nylon tubular bars were announced by The Polymer Corp., Reading, Pa. The new prices, which are said to bring the cost of nylon tubular bars to 15% below that of quality bronze bushings of similar size, apply to a nylon compound formulated especially for bearing uses. Designated Polypenco MC nylon 901, the material is said to be lightly cross-linked, and to provide improved resistance to deformation under load and wear characteristics, and better di- **(To page 222)**

A new day dawns.

A new age has begun – the AGE OF PLASTICS.

Krauss-Maffei have realised this trend and have undertaken to build machinery – especially large machinery – of highest quality for the processing of thermoplastic materials.

Krauss-Maffei are continually expanding their production programme. The following machine types are now available: –

Single Screw Preplasticizing Injection Moulding Machines:
The types V 40-550, V 74-550 and V 90-1000 cover injection volumes from approximately 450 to 4550 ccm.

High Capacity Internal Batch Mixer PM 50.
The construction of this machine, differing from the customary design, meets particularly requirements for calendering and of floor tile manufacturers. Output up to approximately 4400 lbs/hr.

Injection and compression moulds up to largest dimensions meet the demands of the latest processing technics.

Please ask for detailed information.

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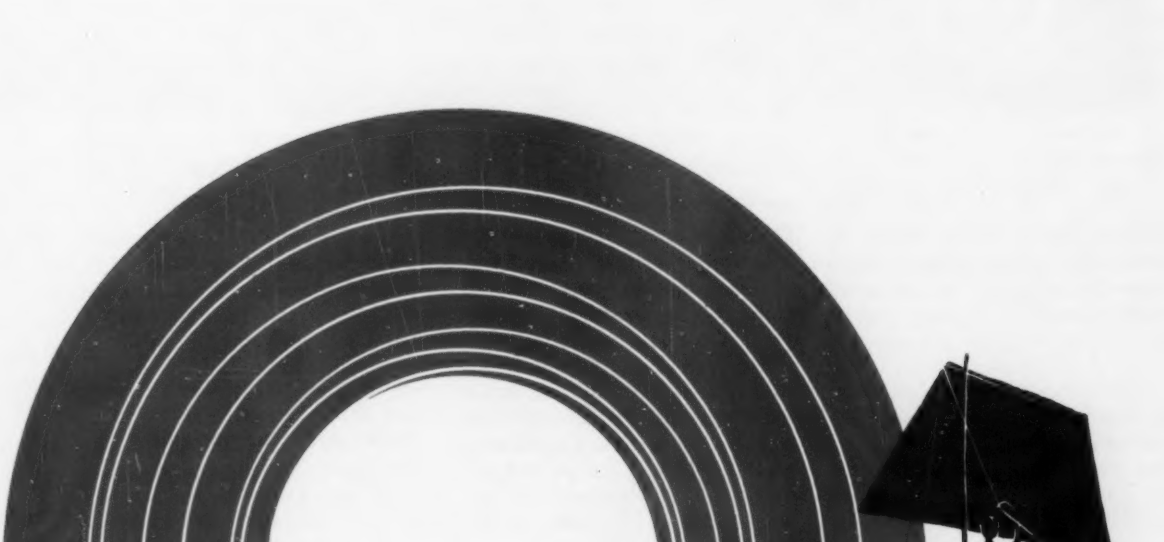


(From page 220)

mensional stability than standard nylon compositions. It will be supplied in a blue color to distinguish it from the company's other nylon formulations.

The MC nylon tubular bars are now available in outside diameters ranging from 2 to 15 in., in standard wall thicknesses of ⅜, ½, ¾, and 1 inch. Wall thicknesses up to 2 in. can be made to order. Standard length is 8 in. for inside diameters under 1½ in., and 13 in. for larger sizes.

Besides bearing uses, the company foresees markets in gears, thrust washers, seals, valve seats, and other nylon applications.

Butyrate for auto lenses

Replacement lenses for lighting devices on trucks and automotive vehicles, made of butyrate, have now been approved in the state of California. The plastic is supplied to molders and extruders by Eastman Chemical Products Inc., subsidiary of Eastman Kodak Co., Kingsport, Tenn. California's approval covers the use of the material in taillights and back-up, turn-signal, and parking lights.

Cast nylon for large parts

Nylon Molded Products Corp., Garrettsville, Ohio, is introducing cast nylon parts for large pieces of machinery under the tradename of Nylocast—a licensed European process. The technique uses high viscosity nylon yet there is said to be no limitation to cast-in inserts, threads, lugs, intricate shapes, or varying thicknesses. The company claims that this process will mitigate the cost of expensive molds and equipment as well as restriction to large volume runs typical of injection molded nylon. N.M.P. has long been one of the country's outstanding producers of molded nylon parts.

Structural sandwich course

An intensive one-week course on structural sandwich design and fabrication sponsored jointly by the Dept. of Engineering and Engineering Extension, University of California, Los Angeles, Calif., will be held at the University from July 11 through July 16. The course is intended for engineering personnel and a B.S. degree in engineering or physical sciences is a prerequisite. Registration fee is $100, including course material. Additional information can be obtained from Engineering Extension, Room 6266, Engineering Bldg., Unit II, University of Calif.

PVAc plaster filler

A white polyvinyl acetate paste called Max-Tic Crack Fill, and designed to fill cracks around bath tubs and sinks, to grout plastic wall tile, and to fill cracks in plaster and wood, is now available from McCarten Industries Inc., Chagrin Falls, Ohio. The new compound dries white and waterproof. Application is simple with an 8-oz. PE squeeze tube in which the compound is packaged.

Installs giant dip tank

A dip tank said to be world's largest tank for PVC dip coating of metal products has been installed by Quelcor Inc., Chester, Pa. This tank was put in operation to handle single pieces up to 6½ ft. long. By controlling preheat temperature of the part and time cycles, single layer coatings of from 1/32 to ¼-in. can be applied.

New UV absorbers

Uvinul N-35 and N-38 are the first two products of a new family of ultraviolet absorbers, available from the Dyestuff & Chemical Div., General Aniline & Film Corp., New York, N. Y. Chemically identified as substituted acrylonitriles, the new UV absorbers do not contain acidic aromatic hydroxyl groups and are said to show excellent UV absorption properties under varying pH conditions.

The two new products are said to be particularly suitable for protecting nitrocellulose lacquers against UV degradation without adding undesirable color to the coating. According to the company, these ultraviolet absorbers may also be of use in other systems such as melamine-formaldehyde, urea-formaldehyde, epoxy-amine, nylon formulations, and butadiene-styrene latex.

Stops static electricity

A sprayable compound said to neutralize static electricity is available from Statikil Inc., Cleveland, Ohio. The product is suggested for spraying on plastics auto seat covers and chairs with rolling casters. It is said to keep dust off acetate and phonograph records, prevent plastics bags from adhering, etc. Statikil is said to dry instantly and invisibly. The compound costs $3.00 per 12-oz. can, and in bulk (unpressurized) for production work, it costs $15 per gallon.

Spray bonder

A new primer and sealer that dries within 20 min. is now available under the tradename XIM spray bonder from the H. Forsberg Co., 5103 Lakeside Ave., Cleveland, Ohio. The manufacturer states that this bonder will successfully prime surfaces that hold paint only with unusual difficulty, such as phenolic.

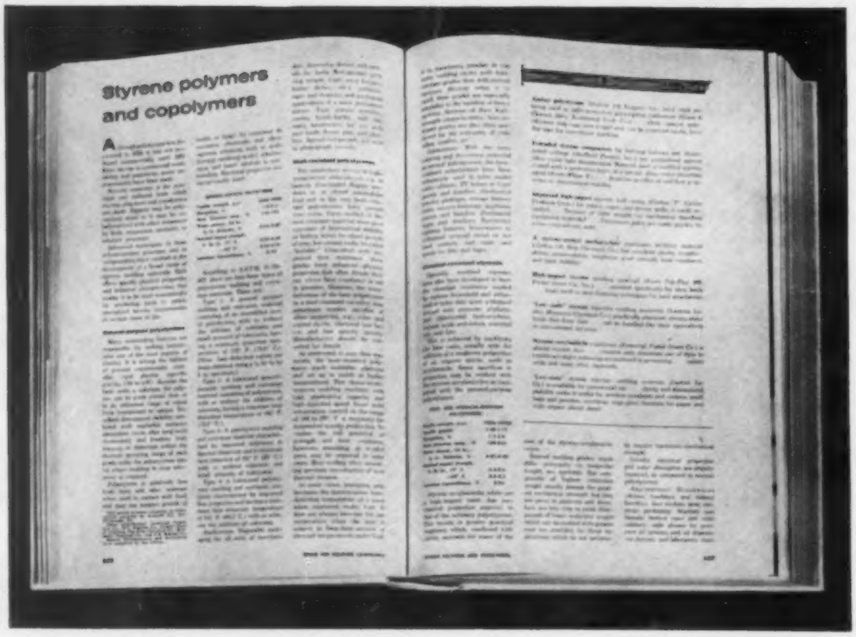
Vinyl tub lining

Rugged vinyl coating is now used as a tub lining in place of porcelain in the newest models of the dishwasher-dryer marketed by Waste King Corp., Los Angeles, Calif. It is also applied to the door lining and racks. The vinyl plastisol acts as an extra barrier to heat, moisture, and sound.

The coating is based on Geon vinyl resin, manufactured by B. F. Goodrich Chemical Co., a division of The B. F. Goodrich Co. Formulator for the vinyl plastisol is Michigan Chrome & Chemical Co., Detroit, Mich.

Seek all-plastic missile

CTL Div. of Studebaker-Packard Corp., and Amcel Propulsion Inc., a new subsidiary of Celanese Corp. of America, have joined in a proposal to the Ordnance Materials Research Office which could result in development of an all-plastic multi-stage missile. The proposal, submitted as a united endeavor, **(To page 226)**



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MODERN PLASTICS
ENCYCLOPEDIA ISSUE FOR 1960

1961 ISSUE—PUBLISHED SEPTEMBER 1960

THE PLASTISCOPE

(From page 222)

resulted from a request by OMRA, Watertown Arsenal, N. Y., for proposals concerning investigation and development of plastic materials for use in solid propellant rocket motors and missiles.

The two companies offered immediate ability to launch the research and development program. The over-all plan envisioned by CTL and Amcel involves five phases: basic research on materials, plastic rocket motor development, plastic missile body development, integration of components, and flight test.

Container Institute formed

The formation of an Industrial Container Institute in The Society of the Plastics Industry Inc. has been announced by Jerome S. Heisler, newly elected Institute chairman and vice-president, Delaware Barrel & Drum Co. Inc., Wilmington, Del. Other Institute officers include B. Neal Harris Jr., vice-chairman and vice-president of Hedwin Corp., Baltimore, Md.; and Richard S. Griffith, chairman, Institute specifications Committee, and assistant product manager, industrial containers of the Plax Corp., Bloomfield, Conn.

This group of plastic container manufacturers is concerned with plastic containers of 1-gal. capacity and larger, and is not to be confused with the Plastic Bottle & Tube Mfr.'s Institute, which is also a division of S.P.I., but which deals exclusively with plastic bottles and tubes in such fields as detergents, cosmetics, disinfectants, etc., and which are of smaller capacity. The Institute will be initially concerned with the development and approval of commercial standards on plastic shipping containers for industrial and governmental uses.

While sales of industrial plastic containers totaled approximately $5 million last year, a 25% increase is forecast for 1960.

Acrylic letters

Introduction of a complete stock alphabet of 14-in. round faced plastic letters made of Rohm & Haas Plexiglas acrylic for outdoor or indoor sign use **(To page 228)**

NEW! "XL-modified" NLC Stabilizers upgrade performance of proven vinyl insulations

Aid color, simplify processing, too!

Today, everyone from the electrical contractor to the missileman wants to cram more power through wire with thinner vinyl insulation. This means the manufacturer must continue to produce better and better vinyl insulation.

Now, from National Lead Stabilizer research, comes word of a significant development in this direction . . . a modification applicable to five of the eight National Lead Stabilizers widely used for insulation. These are DYTHAL®, DYPHOS®, LECTRO® 60, TRIBASE* and TRIBASE-E* Stabilizers.

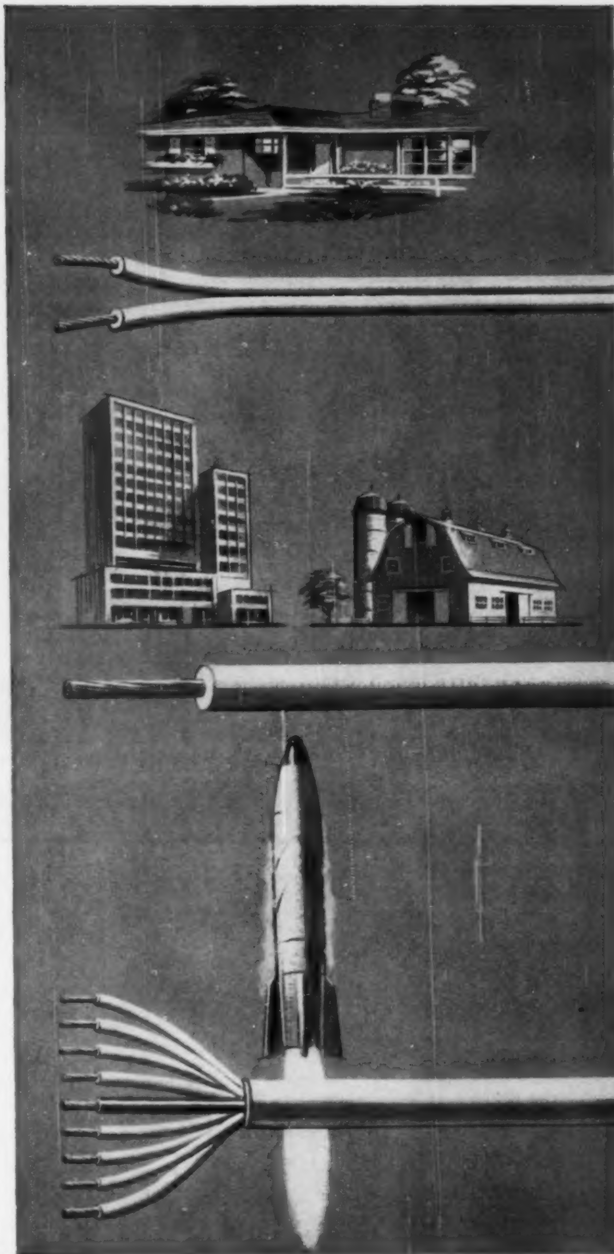
This modification greatly improves the effectiveness of the stabilizer in dielectric vinyl compounds and raises the performance level of the insulation. To designate the modified stabilizer the letters "*XL*" are used. For example, the modified *Tribase Stabilizer* is *Tribase XL Stabilizer.*

The new "XL" Grade Insulation Stabilizers call for no changes in proven formulations, yet with them, the *performance* of your proven formulations can be markedly improved.

The "XL" Grade Insulation Stabilizers produce the following improvements:

1. **Increase heat stabilizing action.**
2. **Increase retention of desired physical properties in the insulation during heat aging.**
3. **Improve natural color of compound both initially and after processing and aging.**
4. **Step up on-wire electrical resistivity.**
5. **Ease processing . . . particularly extrusion.**

Information on the new "XL" Grades is provided in a new NLC data sheet. If you would like a copy, simply let us know with the coupon below.



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- ➤ DYTHAL® Stabilizer for all classes up to 105°C primary insulations.
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- LECTRO® 78 Stabilizer improves special high-temperature stocks including vinyl tapes.
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NLC National Lead Company: General Offices: 111 Broadway, New York 6, N. Y. In Canada: 1401 McGill College Ave., Montreal.

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THE PLASTISCOPE

(From page 226)

has been announced by Premier Plastic Mfg. Co., Minneapolis, Minn. Style of the letters is standard Egyptian, made up in plain, flanged, and contour flanged types, and also for mounting with metal plates, plastic brackets, studs, or for free standing use.

Reports peak sales

Lester Engineering Co., Cleveland, Ohio designer and builder of injection molding machines, reports that 1959 sales reached a new peak at $7,730,076, and were 43% above 1958. Earnings climbed to $245,504, or $1.29 a share, from $122,353, or 64¢ a share in 1958. The company has started an expansion program and also entered into a license agreement with John Brockhouse & Co. Ltd., England, to build and sell Lester machines in England.

Rubber Corp. acquired by Swiss group

Controlling stock in the Rubber Corp. of America, Hicksville, N. Y. supplier of plastisols, plasticizers, and vinyl polymers and copolymers, has been acquired by a Swiss group led by Oerlikon-Buehrle, manufacturer of extrusion equipment and other machinery. The Swiss group also has a strong financial interest in Dynamit A.G., Troisdorf, Germany, a leading European manufacturer of plastics raw materials and plastics products.

Melamine and epoxy toolings

The cost of toolings can be reduced by reinforcing the epoxy-faced pattern with a Calcerite casting compound, according to Furane Plastics Inc., Los Angeles, Calif. These casting compounds, manufactured by Furane, are basically melamine and certain mineral fillers. The addition of a catalyst permits the casting of large sections and curing them with a minimum of shrinkage, according to the company. The cost of these compounds is said to be considerably below those of epoxies. Calcerite is not as tough as an epoxy resin, but will serve satisfactorily as a back-up material and reinforce- **(To page 230)**

THE PLASTISCOPE

(From page 228)

ment for epoxy faces. Patterns prepared in this manner are being used by aircraft and missile manufacturers, and in foundry and metal working establishments, Furane states.

Extrusion developments

New multicolor extrusions now enable product designers to obtain components such as radio and appliance dial-scales, cabinet and panel moldings, handles, pen barrels, and decorative trim with two-tone effects. Any combination of two opaque or translucent colors, or crystal-clear plus any color, can be specified. The second color portion is not a thin surface effect but is said to be an integral part of the extrusion, several mils thick. Trademarked Twin-Tint, the extrusions are made to customer's specifications in most thermoplastic materials by Anchor Plastics Co. Inc., Long Island City, N. Y.

The company has also developed a new technique for extruding large hollow objects, such as a rectangular tube 3 in. by 7 in., made of high-impact polystyrene. Some applications for which this process is suited are ducts, dispensing displays, and containers where more than one height is required. In the latter case the single, relatively low tooling cost for the extrusion, plus a single injection mold for a base and cover, are all that is required for a whole series of containers, the company states.

Plastics Institute

A Plastics Institute that can function on a basic research level and as a training ground for technical personnel has long been a favorite topic of conversation in the plastics industry. The idea is now moving out of the talking stage and into the planning phase. At a recent conference in New York City, an independent committee drawn from all segments of the plastics industry announced that detailed plans for such an Institute had been formulated. Members, under the chairmanship of Prof. Louis F. Rahm, Professor of Me- **(To page 232)**

(From page 230)

chanical Engineering at Princeton University, who worked up the plans, included: A. A. Hutchings, F. J. Stokes Corp.; J. H. Du Bois, Tech-Art Plastics Co.; Ralph L. Mondano, Raytheon Co.; W. O. Bracken, Hercules Powder Co.; D. B. Hanson, E. I. du Pont de Nemours & Co. Inc.; J. L. Formo, Minneapolis-Honeywell Co.; J. W. Lindau, Southern Plastics Co.; and George Smoluk, Engineering Editor, MODERN PLASTICS magazine. Prior to the conference, an informal survey on the materials supplier, machinery manufacturer, custom molder, and end-user level indicated some desire for an Institute that could do long-range basic research into the nature and characteristics of plastics materials and other significant aspects of the science and engineering of plastics and could concern itself with the education —at the graduate school level—of qualified plastics engineers and chemists. Committee members who spoke at the conference, as well as such other speakers as John W. LaBelle, Foster Grant Co. Inc.; S. E. Q. Ashley, General Electric Co.; and Dr. Gordon M. Kline, U. S. Bureau of Standards and Technical Editor, MODERN PLASTICS, further emphasized these needs.

The committee has launched a drive to inform the industry of the purpose and set-up for an Institute of this type. Starting this month, individual firms in the plastics industry will be solicited as to their interest and willingness to underwrite an Institute of this type.

Intermediate for plasticizers

A highly reactive polyfunctional acid, 1,2,3,4,Tetracarboxybutane (T.C.B.) said to be useful for the preparation of esters having potential applications as plasticizers and high temperature lubricants, is now available from Abco Chemical Co., Jersey City, N. J. Potential applications in the coatings industry include preparation of alkyd resins and polyesters which may be used in resin manufacture and urethane formulations. The acid **(To page 234)**

THE PLASTISCOPE

(From page 232)

or its anhydride may be important as an epoxy curing agent, according to the company.

Flame-resistant coatings

The high heat resistance requirements of missile components has led to the development of a new coating material for plastics that might have broad commercial applications in the future. Dyna-Therm Chemical Corp., Culver City, Calif., has introduced a coating, designated D-65 which will withstand the direct flame from an acetylene torch—4000° F.—for approximately 1 min. per 50 mil of dry coating. D-65 is described as flame-resistant and intumescent—when heat is applied the coating expands and bubbles, providing an insulation for the material underneath. This coating contains phosphates and boron flameproofing chemicals dispersed in a flexible urethane binder. Swedlow Inc. of Los Angeles, Calif. and Youngstown, Ohio has been appointed exclusive sales agent for the product in the United States and Canada, and plans to use it in its own manufacturing processes for plastics and other components for the missile and aircraft industries. Potential uses for D-65 include fire barriers in commercial and private aircraft, and as a fire protectant in factories.

Albi Mfg. Co., Rockville, Conn., has formed a Plastics Applications Div. to specialize in the development and application of fire-retardant coatings in plastic components and products. The division has established separate laboratory facilities to test plastics parts and assemblies protected by fire-retardant paint.

According to B. B. Kaplan, Albi's president, by applying fire-retardant coatings in critical areas of the plastic surface, full UL approval has been attained in such diverse products as hair dryers, slide projector cases, electric mixers, computer tape reels, and built-in hi-fi systems. When coated with fire-retardant paint, the properties of plastics are not changed, the company states, and the over-all **(To page 236)**

(Advertisement)

"WE DIDN'T HAVE TO BUY OUR FOURTH NRC VACUUM COATER

Thanks to the new NRC Mechanically Refrigerated Cold Trap"

. . . *says Jack Selsemeyer*
Production Manager, Kent Plastic Corporation
Evansville, Indiana

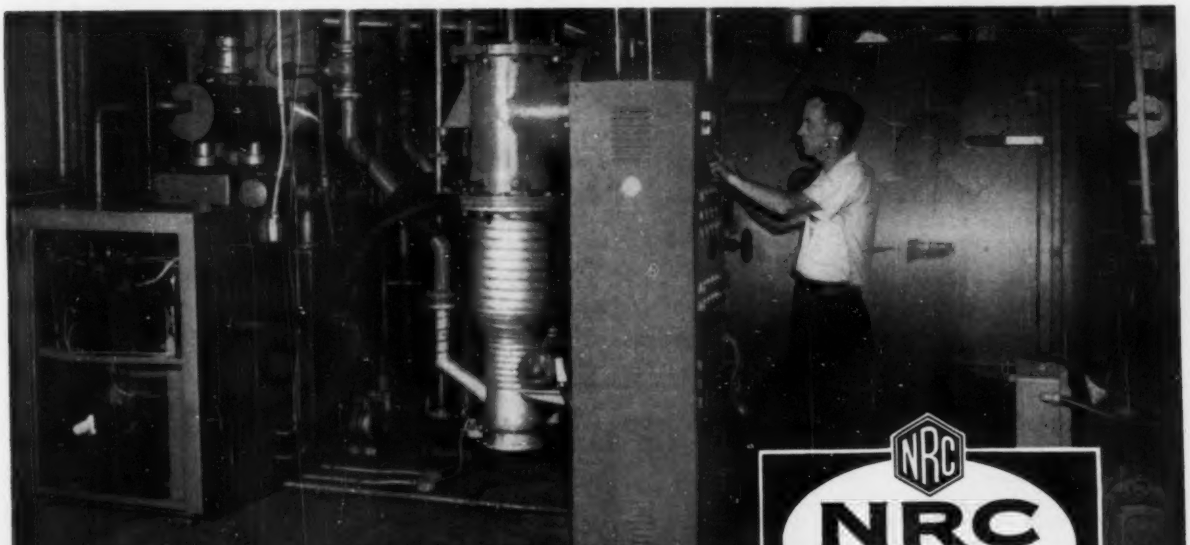
"In the spring of 1957 we decided to buy our fourth NRC vacuum coater. With the increased demand for our vacuum metallized plastic medallions and nameplates, that was the only way we knew of getting through the dread summer months without sacrificing the top quality and prompt delivery on which we've built our business. Summer's always been tough because the high humidity has caused our metallizing cycles to triple and our reject rates to rise.

"We'd already placed the order for the fourth coater, when NRC engineers introduced us to the new mechanically refrigerated cold trap. At first we were skeptical, because we knew other attempts to solve the humidity problems with cold traps had proven expensive and ineffective. However, the ability of the NRC mechanical refrigerator to maintain the cold trap at −150°F, and the special design features of the latter made us decide to try it on one coater.

"Results were spectacular. Production rates and rejects were almost independent of humidity, so that our hot weather costs are way down and we've got a competitive advantage in being able to make good on deliveries. Unfortunately for NRC, after we installed similar systems on our other two coaters we had so much more usable summer capacity that we didn't need the fourth coater."

The NRC Mechanically Refrigerated Cold Trap Assembly consists of a special refrigerator and one or more copper coils flange mounted for positioning directly above each diffusion pump. It offsets high humidity by freezing out water vapors before they can add to the load on the diffusion pumps. The assembly is easily installed in coaters equipped with NRC pumping systems and is simply modified for other equipment. The standard 4 HP refrigerator will maintain two traps at −150°F, the temperature found most effective for coaters operating at the usual 0.5 microns pressure. More powerful refrigerators are available for coaters operating at lower pressures or equipped with more than two diffusion pumps.

This development is the latest of the many contributions which NRC has made to profitable metallizing. If you now operate or are considering the purchase of a vacuum coater, it will pay you to ask your nearest NRC sales engineer for full details on how you profit from these contributions. Write or phone today.



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THE PLASTISCOPE

(From page 234)

cost is lower than when flame-resistant additives are used in the molding compound.

Reinforced plastics

Panel progress. An outdoor canopy made entirely of glass reinforced polyester is now being marketed by the Tru-Scale Div., Wasco Chemical Co., Wichita, Kan. The prefabricated unit consists of RP arches supporting 0.08-in. sheeting of the same material. The beams are hand-molded, and each of the supports consists of three hollow sections whicb are telescoped at the job site to make a complete span. The skin for the canopy is produced by a continuous lamination in strips measuring 2 by 42 feet. The structure has a length and width of 30 ft., and a height of 20 feet. The length can be adjusted by adding or eliminating beams. According to the company, labor costs are minimized because of the structure's simplicity of design and construction, and 3 unskilled workers can assemble the lightweight components and erect a canopy in less than five days.

The unit was developed by Tru-Scale in cooperation with Monsanto Chemical Co. The beams are made of glass matting used in combination with Pittsburgh Plate Glass Co.'s polyester resin trademarked Selectron 5119. The skin panels are made with 1026-Z resin supplied by Interchemical Corp., Finishes Div., Cincinnati, Ohio.

Two of the structures are now in use at Baton Rouge, La., where, erected side by side, they span the driveway and pumps of a service station. At night, concealed base lights make the translucent polyester surfaces glow. When assembled and riveted in place, the canopy is said to be sturdy enough to withstand 80 m.p.h. winds.

A decorative RP panel featuring a random pattern of multicolored leaves, butterflies, and gold flecks against a frost background is now available from Filon Plastics Corp., Hawthorne, Calif., at a retail price **(To page 238)**

THE PLASTISCOPE

(From page 236)

of 69¢/sq. ft. Specifically designed for interior applications, such as room dividers, shoji screens, table tops, and luminous ceilings, the panel measures 48 by 144 inches.

William Graubard, 783 Clara Dr., Palo Alto, Calif., supplies custom-designed panels in 50 transparent and opaque colors, which are said to be lightfast.

American Polyglas Corp., Carlstadt, N. J., completed an order for 44,000 sq. ft. of opaque RP paneling for use in atomic submarines of the U. S. Navy. The material was supplied to the Electric Boat Div. of General Dynamics Corp., but Polyglas is producing a commercial variation of these panels for exterior and interior partitions, windows and skylights, and for use in automotive vehicles.

Honeycomb core. Six different honeycomb core materials consisting of woven glass cloth impregnated with a phenolic resin and separately applied phenolic dip coats, have been developed by Hexcel Products Inc., Berkeley, Calif. Called HRP, the materials range in density from 2 lb. to 15 lb./cu.ft. in cell sizes of $\frac{3}{8}$ and $\frac{3}{16}$ inches. The lower densities are designed for use in highly loaded aircraft and missile components, the middle densities for primary aircraft structures, and the higher densities for marine structures such as hydrofoils and underwater containers. Hexcel has removed CTL core, an earlier version of heat resistant plastics honeycomb, from its product line.

High strength sheet. Production of RP sheet said to have a unidirectional flexural strength of 250,000 p.s.i. has been started by The Parallite Mfg. Co. at a new factory in Export, Pa. The company produces its own glass fibers and produces a finished mat from which flat sheet laminates are made. The new material is expected to find applications as electrical grade laminates and tubes for the electrical industry; missile motor cases; pipe production; in truck and railroad car components; in high pressure contain-

ers; and for aircraft and missile structures. According to the company, the material has good dielectric strength, can be machined and colored.

Impact molding compound. Electrical insulating parts are now being made from Resistrac, a new fibrous glass alumina-polyester impact molding compound developed by The Glastic Corp., Cleveland, Ohio. According to the company, parts molded of this new material resist the formation of carbon tracks when operating under voltage stresses in extreme conditions of humidity and contamination. When subjected to the salt-fog test molded parts of Resistrac reportedly have a tracking resistance at least 25 times that of conventional glass polyester. They do not exhibit the spalling common to ceramic-type materials that have suffered thermal shock caused by arcing, the company reports. The molding compound is also flame resistant.

For printed circuits. A glass-reinforced epoxy, copper-clad laminate, designated Textolite 11585, has been introduced by General Electric Co. for flush printed circuits. The new grade is classified NEMA G-10, and is available in sheets measuring 36 by 48 in., 36 by 36, and 36 by 72 inches.

National Vulcanized Fibre Co., Wilmington, Del., has introduced a paper-base phenolic laminate which is said to provide flame retardance with good cold punching characteristics at nearly half the cost of epoxy-paper laminates. Designated Phenolite Grade XXXPC-476, the base stock meets the electrical, physical, and mechanical requirements of NEMA standards and Underwriters' Laboratories test for flame resistance, the company states. It is also available as a foil copper-clad laminate with standard adhesive bonding made primarily for commercial radio and TV applications, and as a copper-clad laminate intended primarily for electronic computer printed circuits and military applications requiring plating from alkali solutions. Phenolite EP-491, an epoxy paper grade, costs $1.55/sq. ft. in 1/16-in. thick- **(To page 241)**

(From page 239)

ness with 1-oz. copper on one side, while the new material sells for $0.96 in the same thickness. The new laminate is furnished in sheet sizes of 39 by 39 in., and 39 by 47 inches. Available thicknesses range from 1/32 to 1/4-inch.

New catalyst. A methyl ethyl ketone peroxide catalyst, for the reinforced plastics industry called Hi Point 180, has been developed by U. S. Peroxygen Corp., Richmond, Calif. According to the company, this catalyst is safer than previous formulations, since it has a minimum flash point of 180° F. but the same curing characteristics of other MEK peroxides made by U. S. Peroxygen.

RP angles. Plastic Age Sales Inc., Saugus, Calif., produces angular shapes from combinations of polyester resin and fibrous glass mat. Where slightly more strength is required, fibrous glass cloth is used. Tensile strength up to 58,000 p.s.i., compression strength to 90,000 p.s.i., and flexural strength to 100,000 p.s.i., reportedly can be obtained with these RP materials. The angles come in 14½-ft. lengths in 73 different leg sizes.

The Glastic Corp., Cleveland, Ohio, now supplies 10 different structural insulating shapes made from fibrous glass reinforced polyester stock in widths ranging from 2-3/16 in. to 9-21/32 in., and lengths from 28⅞ to 75⅞ inches. The stock may be cut into angles or channels and is engineered for use in equipment operating at Class B temperatures (130° C.), and is said to meet NEMA GPO-1 specifications and is reported to be flame retardant.

Boat order. Lunn Laminates Inc., Huntington Station, Long Island, N. Y., has received a contract for construction of 23 26-ft. reinforced plastic personnel boats which will replace the slower 28-ft. wooden boats currently being used by the Navy. The boats are scheduled for assignment aboard guided missile destroyers and guided missile frigates. They will be powered by a 225 hp. Diesel engine and are expected to do 21.5 knots with 14 men and a 2-man crew. The boats include a completely enclosed cabin; the deck and interior are in one piece with 2-tone molded-in color.

Large hoods. A combination hood-and-duct measuring 46 ft., and designed for service in a nickel processing plant, was recently supplied by The Ceilcote Co., Cleveland, Ohio. The ventilating hood is equipped with an internal washout spray pipe and each hood has an individual adjustable damper to control velocity. The units were fabricated in three sections to provide savings in mold and construction costs. Internal baffles and thick wall members make the unit rigid and self-supporting.

Large Navy order. Two contracts with the Navy exceeding $1 million for making fibrous glass torpedo launcher tubes and launcher assemblies **(To page 243)**

THE PLASTISCOPE

(From page 241)

have been announced by Apex Fibre-Glass Products, division of White Sewing Machine Corp. About 600 of the tubes and 20 complete launcher assemblies will be manufactured by Apex, using a centrifugal molding process which is said to provide straight tubing of uniform diameter and wall thickness.

Colored bathtubs. The new permanent mobile homes manufactured by Windsor Mobile Homes, Bristol, Ind., are now equipped with fibrous glass bathtubs, 46½ in. long and weighing 18 pounds. They are manufactured by Sani-Glas Inc., Amsterdam, N. Y., with mold-in colors. They are priced competitively with steel bathtubs but cost less than cast iron tubs.

Replaces metal. One of the largest reinforced plastics cylinders ever made has been produced by Zenith Plastics Co., Gardena, Calif., a subsidiary of Minnesota Mining & Mfg. Co. More than 25 ft. long, with a 57-in. inside diameter, the cylinder was fabricated of 3M's Scotchply brand RP material for Lockheed Missiles & Space Div., replacing a metal cylinder.

Weight of the missile cylinder is 1000 lb., a sharp reduction from the metal weight. According to the company, the large reinforced plastics unit can be made on a production basis.

New Companies

Dayton Dayflex Plastics Co., Dayton, Ohio, is a newly-organized division of **Dayco Corp.,** and will be engaged in manufacturing and sales operations of a line of plastic hose for vacuum cleaners, hair dryers, swimming pools, vents, and exhausts. **S. K. Lamden** is manager of the new division.

Expansion

Illinois Tool Works is building a 73,000-sq.-ft. plant at Des Plaines, Ill. to house the newly-formed Conex Div., which will manufacture thin-wall plastics containers and other packaging products. The new facilities, scheduled to be ready for occupancy early this fall, are expected to employ 150 persons initially. Production is scheduled to start soon on a plastics carrier for canned beer and other beverages. **Walter J. Simons,** formerly with Continental Can Co., was named general manager of the division.

Union Carbide Chemicals Co. is now operating its new Technical Service Laboratory in Tarrytown, N. Y. This new facility centralizes and expands the company's customer service and use-research that had been carried out principally at Mellon Institute in Pittsburgh, Pa., and also in several other areas including South Charleston, W. Va.; Whiting, Ind.; and affiliated company laboratories at Bound Brook, N. J.; Tonawanda, N. Y.; and Millwood, N. Y. The laboratory building accommodates about 100 scientists with an administrative **(To page 244)**

THE PLASTISCOPE

(From page 243)

staff of 50 people under the direction of **Dr. A. B. Steele.** The main portion is 300 ft. long and 60 ft. wide. About one-third of the building is devoted to administrative offices and public areas. The remainder is divided into 46 industry-classified laboratories with 33 adjacent offices. A mechanical test building is connected to the main laboratory. Among major industry groups in which work is under way at the new facility are plasticizers, polyether foams, and surface coatings.

Formica Corp., subsidiary of **American Cyanamid Co.,** added 32,000 sq. ft. to its Evendale, Ohio plant to house a new plastics laminating press. The press weighs 300 tons, stands 26 ft. high, has a 7000-ton clamping pressure capacity, and can produce laminated sheets up to 5 ft. by 12 ft., pressing 160 sheets at a time. According to the company, the new installation can produce 172,000 sq. ft. per day, or approximately 51,840,000 sq. ft. annually.

Sloan Mfg. Co., Sun Valley, Calif., opened a 14,000-sq.-ft. warehouse and office building at 1401 Fairfax Trafficway, Kansas City, Kan., which will serve as distribution headquarters for an area from Colorado to the East Coast, and from Mexico to Canada, for the company's plastics pipe.

Monsanto Overseas S. A., through its wholly owned subsidiary, **Monsanto Argentina S.A.I.C.,** has started production of PVC compounds, phthalic anhydride, and DOP plasticizer in Zarate, Argentina. **Monsanto Andes S. A. I. C.,** another Argentine subsidiary, owned in partnership with **Carbometal S.A.I.C.,** Argentina, has opened a new plant for the production of vinyl chloride monomer and PVC resin.

Bendix Aviation Corp., Kansas City Div., has completed a polymer chemistry and engineering building. The new facility provides for the synthesis of polymeric and resinous materials to meet speci- **(To page 246)**

Remarkable present . . . amazing future!

Flexible urethane foams alone are sure to pass the 100-million-pound mark in 1960. And they are only a part of the story. What limits can you place on materials that cut 8½ tons from an atomic submarine's weight; protect missile components against heat damage to 6000° F.; are preferred by jet aircraft and automobile manufacturers for insulation and cushioning; make foam mattresses as economical as innersprings; promise 20-year house paints and 100,000-mile-tread automobile tires?

Jefferson offers new polyethers made to rigid urethane specifications with emphasis on low unsaturation, low water content, low ash, low acid numbers, and controlled pH. Also available are excellent catalysts for flexible, semi-rigid and rigid urethane foams . . . N-methylmorpholine, N-ethylmorpholine, and the interesting amine, N, N′-dimethylpiperazine. For a partner in developing better urethane products, contact . . . Jefferson Chemical Company, Inc., 1121 Walker Avenue, P. O. Box 303, Houston 1, Texas.

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JEFFERSON CHEMICALS

049

THE PLASTISCOPE

(From page 244)

fications required by the Atomic Energy Commission design agencies. The plastics materials are utilized in molding compounds, adhesives, casting, encapsulating and potting compounds, foams, and laminates. Basic studies will also be made into the chemistry of plastics, the company states.

Planet Plating Co. Inc. has moved its plant and offices from Morgan Ave. to 1333 Flushing Ave., Brooklyn, N. Y. The new 15,000-sq.-ft. facility will be devoted exclusively to barrel electro-plating of plastics for the costume jewelry and novelty industries.

Brittain Products Co., Cuyahoga Falls, Ohio, has completed a 7100-sq.-ft. addition to its injection molding plant which brings the firm's total floor space to more than 50,000 sq. feet. The company produces PE housewares, ranging from a 1-pt. freezer container to a 10-gal. garbage pail, and other PE injection-molded items.

Northern Plastics Corp., LaCrosse, Wis. manufacturer of laminated plastics for the electrical and electronics industries, has added 6000 sq. ft. of raw material storage space to existing facilities.

Haveg Industries Inc., Wilmington, Del., has purchased **Blow-O-Matic Corp.,** Bridgeport, Conn., and will operate it as the Blow Molding Div. of Haveg in the previous address at 405 Central Ave., Bridgeport 1, Conn. Blow-O-Matic was organized in 1958 by Danish plastics engineer, **Soren Graae,** who will join the newly purchased company as manager.

Cary Chemicals Inc. has put its Flemington, N. J. plant on stream with facilities geared to provide a minimum of 50 million lb. of PVC homopolymer and copolymer resins annually, which more than triples capacity. The company has also expanded compounding facilities at its East Brunswick, N. J. plant to produce a minimum of 36 million lb. of compounds annually. New pilot plants in operation **(To page 249)**

THE PLASTISCOPE

(From page 246)

at both facilities will permit intensified product development, the company states.

Onyx Chemical Corp. was merged with **Onyx Oil & Chemical Co.** and will be known as Onyx Chemical Corp. Business will be carried on under the same management and at the same locations in Jersey City, N. J. The new corporation is a supplier of acrylic resins, antistatic agents, and related raw materials.

Jayvee Brand Inc., manufacturer of diaper pants and children's rainwear, and **Plastics of America,** manufacturer of adult rainwear and industrial plastics film products, both of Portland, Ore., have combined operations and will be known as **Jayvee Mfg. Co.,** with headquarters at 1920 S. E. Grand Ave., Portland. **John G. Emery,** president of Jayvee Brand, is president and general manager of the new company. **Ron MacDonald,** former owner of Plastics of America, is vice-president in charge of production. **W. W. Van Orsdel,** formerly sales manager of Jayvee, continues in that capacity for the new company.

The Butler Mfg. Co., Kansas City, Mo., has constructed a 31,000-sq.-ft. plant in Grandview, Mo. for the production of reinforced plastics building panels.

Pittsburgh Chemical Co., a subsidiary of **Pittsburgh Coke & Chemical Co.,** has dedicated its new $4 million maleic anhydride plant at Neville Island, Pa. The new facility will have an annual capacity of 20 million lb. and is scheduled to go on stream early in 1961. The chemical is produced by the high temperature catalytic oxidation of benzene, which is a by-product of coke oven operations. The company will be self-sufficient in benzene supply.

The main use for maleic anhydride is in reinforced plastics.

Reichhold Chemicals Inc. has acquired from **Nicolet Industries Inc.,** Florham Park, **(To page 250)**

THE PLASTISCOPE

(From page 249)

N. J., stock of **Modiglass Fibers Inc.**, Bremen, Ohio, maker of fibrous glass. **Louis J. Melillo** is manager of the Bremen plant.

T. H. & J. Daniels Ltd., Stroud, Gloucestershire, England, is constructing an extension to provide an additional 15,000 sq. ft. of factory space for the manufacture of plastics molding equipment.

Burgess Pigment Co., Sandersville, Ga., producer of hydrous and anhydrous aluminum silicate pigments and kaolin clays, has doubled production capacity.

Royal Mfg. Co. Inc., an affiliate of **Celanese Corp. of America**, has recently acquired a 46,000-sq.-ft. plant in Hamilton township, near Trenton, N. J., for the production of blow molded containers for detergents and other products.

Ad-Pact Corp., Pardeeville, Wis. and New York, N. Y., has merged with **Pacific Ad-Pact Corp.**, San Carlos, Calif. The newly created corporation will be known as **Adpact Sign Corp.**, and will have principal offices in Pardeeville, New York City, and San Carlos. The company designs and manufactures illuminated plastics dealer identity signs.

Dynatech Plastics Inc. has started construction on a 12,000-sq.-ft. plant at Santa Ana, Calif. The company designs and produces custom injection moldings.

Ferro Corp. is building a 15,000-sq.-ft. plant at North Miami, Fla. for the production of fibrous glass mat and color gel coats. The new unit is expected to be in production by the end of this year and will be operated jointly by the Fiber Glass and Color divisions.

Hooker Chemical Corp. will start construction for a new building at the Eastern Chemical Div. plant, Niagara Falls, N. Y., to house semi-commercial production processes. Including equipment, the new facility is estimated to cost in the neighborhood of $1½ million. It will permit centralized production of chemicals which have outgrown the pilot plant stage, but have not yet reached commercial scale volume. The company uses an arbitrary range of $25,000 to $100,000 annual sales for a product as being of semi-commercial size.

Armour Alliance Industries, a division of **Armour & Co.**, has started manufacture and fabrication of flexible urethane foam in a recently constructed wing of the firm's Los Angeles, Calif., cushioning plant. The new facility has a capacity of 9000 lb. of foam per hour. Armour will continue to produce rubberized curled hair, and will supply combinations of the two cushioning materials for certain upholstering applications in addition to fabricated foam products.

Wyatt Industries Inc., Houston, Texas, has installed a 2000-ton hydraulic press with 104-in. of daylight, a 22½ kw. electronic preheater, and steam heating equipment which will be used primarily in molding large plastics insulation parts for missiles. About 600 sq. ft. of shop space had to be added to existing facilities to house the new press.

Meetings

Plastics groups

Oct. 13, 14: 16th Annual S.P.I. New England Section Conference, Wentworth-by-the-Sea, Portsmouth, N. H.

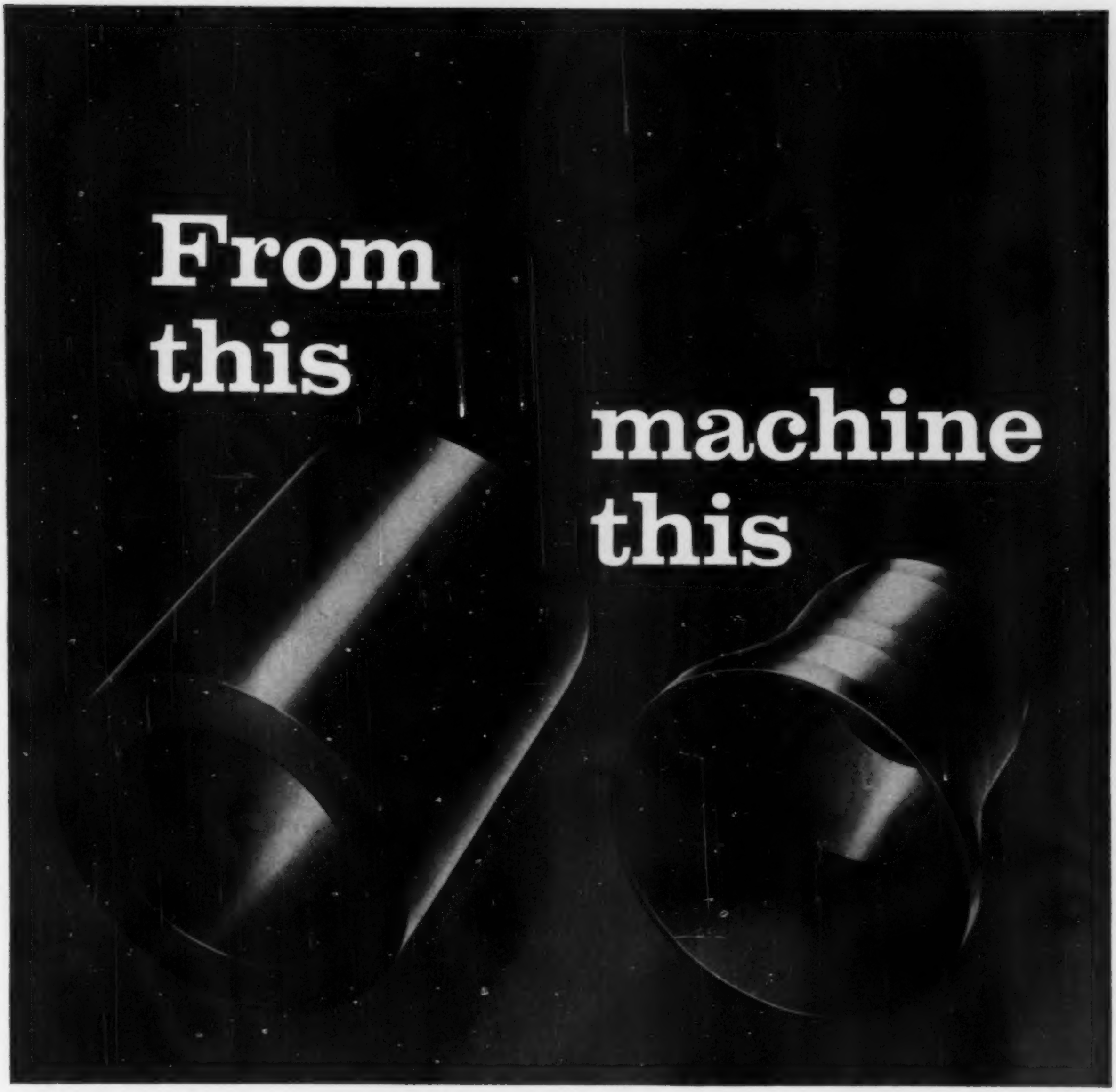
Feb. 7-9, 1961: 16th Reinforced Plastics Div. Conference, Edgewater Beach Hotel, Chicago, Ill.

June 5-9, 1961: 9th National Plastics Exposition and S.P.I. National Plastics Conference, Coliseum and Commodore Hotel, New York, N. Y.

Other groups

July 11-15: National Housewares Manufacturers Assn., 33rd National Housewares Exhibit, Convention Hall, Atlantic City, N. J.

July 19-21: 1960 Western Packaging & Materials Handling Exposition, Pan Pacific Auditorium, Los Angeles, Calif.—**End**



R/M molded rods and tubes for missile research

Take advantage of famous R/M Style 150RPD molding compound in tubes and rods already molded for your developmental work.

You save the cost of dies and molding by machining prototype parts from rods and tubes supplied by R/M in sizes from 1⅛ to 15 in. OD by 15 in. long; or 21 in. OD by 4 in. long.

High-temperature parts made from this molding compound exhibit controlled ablation, good structural strength, excellent thermal-insulating properties, and low thermal diffusivity. Extra-long spinning-grade asbestos fiber provides unusual physical stamina and contributes to high strength-to-weight ratio.

When you have developed and tested your prototype parts, you or your fabricator can then get the desired R/M molding compound in production quantities. Write or call for further information.

RM

RAYBESTOS-MANHATTAN, INC.

Reinforced Plastics Department, Manheim, Pa.

SPECIALISTS IN ASBESTOS, RUBBER, ENGINEERED PLASTICS, SINTERED METAL

COMPANIES . . . PEOPLE

Appointments, promotions, and relocations in the plastics industry.

The Dow Chemical Co. promoted the following salesmen to position of account mgr., a new classification: **William M. Jackson,** plastics sales, Atlanta, Ga. office; **Denis J. Mullins, Stanton D. Smith, Frank J. Ward,** and **Henry B. Weisl,** all with plastics sales, New York, N. Y. office.

Allied Chemical Corp.—Plastics & Coal Chemicals Div.: John C. Esher appointed dir. of sales. With the company since 1937 in production control, purchasing, planning, and chemical sales depts., he was most recently gen. sales mgr., plastics and resins. **Roger E. Caffier** appointed chemicals product mgr.; **Dr. Harold A. Hoppens** named dir., tech. service; **Dr. R. W. Dornte** appointed dir., Glenolden, Pa. research laboratory; **Kenneth D. Meiser** now asst. dir.—engineering, and **Dr. Ray L. Feder** named asst. dir.—development, tech. dept. **Kenneth E. Walker** appointed sales rep., southeastern dist., and **John F. Strauss,** sales rep., Cleveland, Ohio office.


John Esher

National Aniline Div.: William B. Yarborough appointed a v-p. He will be responsible for research, development, and engineering.

Monsanto Chemical Co. — Plastics Div., Springfield, Mass.: **Dr. Edgar E. Hardy** appointed assoc. dir. of research; **Dr. Seymour Newman** named group leader for physical chemistry research. **Sarkis K. Garibian** and **Otho E. Harris** joined the research dept.; **Donald F. Anderson,** the engineering dept.; **Jean P. Bourgault** and **John J. Kelleher,** the sales dept.; and **Henry Rotstein,** joined the production tech. service dept.

Union Carbide Corp.—Union Carbide Plastics Co.: Gerrit V. Lydecker appointed New England asst. regional mgr., **Ernest L. Formanns,** tech. sales rep., assigned to metropolitan New York area and, **Douglas L. Peterson** appointed tech. sales rep., N. Central region for Bakelite polyethylene, phenolic, styrene and vinyl resins for molding and extrusion. **Fred Wurtzell** appointed wire and cable market mgr.

Visking Co.: Leo A. McCabe, previously gen. mgr., **E-Z Packaging Corp.,** Chicago, Ill., appointed PE film sales specialist to the laundry and dry cleaning industry.

Enjay Co. Inc., petrochemicals firm, is now **Enjay Chemical Co.,** a div. of **Humble Oil & Refining Co.,** with headquarters in New York, N. Y. **J. E. Wood III,** former pres. of Enjay Co., is pres. of the new div.

Pee Cee Tape & Label Co., div. of **Eureka Specialty Printing Co.: Don Gevirtz** named gen. mgr. of the three divs. with plants in Los Angeles, Calif., St. Louis, Mo., and Dumont, N. J. **Norman Hall** appointed Eastern operations mgr. **Robert Buckley** is gen. sales mgr. and **Charles Richardson** appointed prod. mgr. The company manufactures pressure-sensitive labels.

Celanese Corp. of America: Kenneth C. Loughlin, former exec. v-p, elected pres., succeeding **Harold Blancke,** who remains chrmn. and chief exec. officer. **Harry B. Bartley Jr.** appointed field sales mgr. of **Celanese Chemical Co.**

Plastic Food Container Assn. is a newly formed national trade group of manufacturers of injection molded and vacuum formed food containers. Its general objectives are to provide better quality containers for grocery, dairy, and drug industries. **R. F. Smith, Sealright Pacific Ltd.,** is pres., and **M. J. McCabe, Neatway Products Inc.** is v-p. The association has headquarters at 333 N. Michigan Ave., Chicago, Ill.

Imperial Color Chemical & Paper Dept., Hercules Powder Co.: Alfred E. Van Wirt appointed asst. gen. mgr.; **Nathan W. Putnam,** asst. gen. mgr.-dir. pigment color sales; and **Laurence R. Sherman,** mgr., pigment color div.

Pearce-Simpson Inc., Miami, Fla. electronics mfr., established a Molded Plastics Div. at 3950 N. W. 28th St., Miami. **Erik Loveland** is plant mgr. of the new custom molding div., formerly the **Varney Plastics Co.**

National Cleveland Corp.: Glenn A. Tanner appointed dir. of sales for the Plastics Div., which includes **Auto-Vac Co., Auto-Blow Corp.,** and **Plastics & Chemicals Div.,** all of Bridgeport, Conn. **William F. Blamey,** formerly asst. sales mgr., is now mgr. of Auto-Vac Co. **Mrs. Irene E. Ledermann,** formerly sales mgr. of Kautex-U. S. Sales Co. Inc., joined Auto-Blow Corp. as asst. to Mr. Tanner.

Narmco Materials Div., formerly **Narmco Resins & Coatings Co.,** Costa Mesa, Calif. mfr. of structural adhesives and reinforced plastics, established a new East Coast sales headquarters at 600 Old Country Rd., Garden City, N. Y. **Thomas E. Holdridge,** formerly tech. field sales mgr. of the home office, appointed Eastern region sales mgr. The company is a div. of **Narmco Industries Inc.,** San Diego, Calif., which together with all its divs. recently became a wholly-owned subsidiary of **Telecomputing Corp.,** Los Angeles, Calif.

H. Muehlstein & Co. Inc., processors, dealers, and distributors of plastics and rubber raw materials, moved its home office from 60 E. 42nd St., to 521 5th Ave., New York, N. Y. The increased facilities enable the company to concentrate all its home activities at one location.

Radiation Applications Inc. moved from 42-30 24th St. to larger offices and laboratories at 36-40 37th St., Long Island City, N. Y., where production will include radiation-treated Teflon, polyethylene, and other plastic materials.

Pycofoam Corp., Norristown, Pa. custom molders of expandable polystyrene, opened a sales office at 520 Fifth Ave., New York, N. Y.

William DeWitt Jr. appointed v-p of **DeWitt Plastics,** newly formed div. of **Shoe Form Co. Inc.,** Auburn, N. Y. makers of plastic baitboxes and fishing tackle. The parent company is a mfr. of plastic shoe and hosiery forms.

Peterson Electronic Die Co. Inc., 199 Liberty Ave., Mineola, N. Y., is the new name and address of **A. W. Peterson & Sons Die Co. Inc.,** 131 Prince St., designers and fabricators of electronic heat-sealing dies.

Eastman Chemical Products Inc., Plastics Div.: John Adams named plastics sales development mgr. and **John T. Moore,** asst. sales mgr., Kingsport, Tenn. **T. Earl Dudney** heads the Leominster, Mass. sales office. **Jerry L. Flora** and **Benny P. Fulkerson Jr.** appointed sales reps., Chicago, Ill. and **Noel H. Malone Jr.** assigned to New York, N. Y. office.

Plywood & Plastics Inc. is the new name of **The Plywood Center,** Richmond, Va. distributor of Plexiglas, formica, fibrous glass panels, and other plastics supplies.

Owens-Illinois Glass Co. established a plastics products dist. sales office at 1809 First National Bank Bldg., Baltimore, Md., to cover the Charlotte, N. C., Philadelphia, Pa., Baltimore, and Richmond, Va. branches of the company. **Frank M. Harris** of the company's **(To page 254)**

COMPANIES...PEOPLE

(From page 252)

N. Y. dist. office, named dist. mgr., **Lee N. Jarech**, sales asst.

Gilman S. Jacobs appointed sales mgr. for **Gilbert Plastics & Supply Corp.**, Baltimore, Md. distributor of resins, molding compounds, etc.

James L. Foster appointed mgr., polyethylene sales, **Goodrich-Gulf Chemicals Inc.**, Cleveland, Ohio.

Richard W. Miler, formerly v-p of Bakan Plastics Inc., San Juan, Puerto Rico, joined **Baker Perkins'** Chemical Machinery Div., Saginaw, Mich., as div. project engineer in charge of plastics.

Lawrence V. Howenstine named tech. sales engineer for the plastics sales branch of **Phillips Petroleum Co.'s** international dept. He is located in the sales and development div. offices in New York, N. Y.

Joe R. Brown appointed sales mgr. of **Shaw Insulator Co.**, Irvington, N. J. custom molder.

Robert E. Swisher named to newly created post of v-p, marketing, by **Alsynite, Div. of Reichhold Chemicals Inc.** Alsynite, mfr. of translucent reinforced fibrous glass panels, has headquarters in San Diego, Calif. and additional plants at Paterson, N. J., and Portsmouth, Ohio.

Bernard B. Bowling promoted from sales rep. to newly created post of sales promotion mgr. for **Seiberling Rubber Co.** plastics div.

James H. Brodie, appointed sales mgr., reinforced plastics div. of **Fabricon Products**, div. of **Eagle-Picher Co.**

L. N. "Buck" Tinkham promoted to newly created post of asst. sales mgr., **Plastics & Rubber Products Co.**, Los Angeles, Calif. mfr. of O-Ring compounds.

Frederic W. Hammesfahr appointed dir., commercial development dept., **J. T. Baker Chemical Co.**, mfr. of molding compounds.

Richard W. Arms named product specialist for **United States Gasket Co.**, Plastics Div. of **Garlock Inc.**, Camden, N. J. He will be responsible for the development and sales of the company's complete line of thermoplastic products.

William G. West appointed sales mgr. of **The Stanley Chemical Co.**, subsidiary of **The Stanley Works**, East Berlin, Conn. He was formerly gen. sales mgr. of The Borden Chemical Co.

Glenn A. Farno named sales mgr. —chemicals of **Food Machinery & Chemical Corp.'s** Chemicals & Plastics Div. The div. makes plasticizers, resins, and organic intermediates.

Henry R. Lasman appointed to newly created position of mgr., Organic Chemicals Div., **National Polychemicals Inc.**, Wilmington, Mass. producer of a line of synthetic resins and organic chemicals.

Jeal Sugarman, chemist with the central research laboratories, promoted to field sales rep. of **Antara Chemicals**, a sales div. of **General Aniline & Film Corp.** He will work out of Dallas, Texas.

Sumner H. Levin appointed tech. dir. of **The Blane Corp.**, Canton, Mass. mfr. of vinyl and polyethylene compounds and color concentrates.

J. Whitney MacDonald elected pres. and gen. mgr. of **Synco Resins Inc.**, Bethel, Conn. mfr. of thermosetting resins for the paper, abrasive, and other industries.

Earl R. Peterson appointed sales mgr., western div., **Taylor Fibre Co.**, with headquarters at the company's

LaVerne, Calif. plant. He replaces **Edward J. Guelpa**, recently named gen. mgr.

Robert M. Dunlap appointed sales mgr., **Davis Products Inc.**, Van Nuys, Calif. producer of a variety of inflatable plastic products.

Jerry Marcell, formerly design engineer for the mechanical div., named field service engineer for **G. T. Schjeldahl Co.'s** polyethylene bag-making machines.

Richard G. Hayes named to newly created post of tech. consultant on urethanes for **Dayco Corp.**, formerly **Dayton Rubber Co.** He will be responsible for applications of flexible, rigid, and solid urethanes.

John F. O'Brien joined **Hysol of California**, a div. of **Hysol Corp.**, Olean, N. Y. mfr. of epoxy compounds, as tech. field salesman.

Harry K. Collins appointed exec. v-p and gen. mgr. of the **Paraglas** (reinforced plastics) **Div., Air Logistics Inc.**, Pasadena, Calif.

Lewis N. West appointed mgr., chemicals and plastics dept., **Getz Bros. & Co.**, San Francisco, Calif. export and import firm.

Carl F. Massopust named dir.—product R & D, plastics processing div., **Rexall Drug & Chemical Co.** This div. includes the plastics film, container, housewares, pipe, valves, and fittings mfg. subsidiaries.

Robert H. Cottle named Los Angeles, Calif. dist. mgr. for **Formica Corp.**, a subsidiary of **American Cyanamid Co.** He succeeds **Glenn H. Taylor**, who retired.

Dr. Rudolph D. Deanin, chemist, joined **DeBell & Richardson Inc.** consulting engineers.

Thomas R. Grimes appointed sales mgr. of Ensolite products div. of **U. S. Rubber Co.** Ensolite is a closed-cell vinyl sponge material used for water safety vests, liners for crash helmets, animal protection pads, etc.

John S. Harris joined **American Plastics Corp.**, custom molding subsidiary of **Heyden Newport Chemical Corp.**, as sales rep.

Harry J. Pratt appointed mgr. of the **Amos Molded Plastics Div.** of **Amos-Thompson Corp.**, located at Edinburg, Ind.

Franklin N. Ritschel Jr. joined **B. B. Chemical Co.**, Cambridge, Mass., as a sales engineer for the company's line of urethane coatings.

Dr. Sallie A. Fisher, previously with Rohm & Haas Co., joined **Robinette Research Laboratories**, **(To page 257)**

(From page 255)

consulting organization for plastics and other industries, as assoc. dir. of research.

Clifford R. Smith, previously with the Borden Chemical Co., appointed sales engineer for the Press Div., **F. J. Stokes Corp.,** Philadelphia, Pa. mfr. of molding equipment. He will work out of Dayton, Ohio.

Ernst G. Kuehn appointed European rep. for **Jefferson Chemical Co. Inc.,** Houston, Texas producer of ethylene and propylene derivatives.

Loren J. Simer named product sales mgr. for **Carlon Products Corp.,** Aurora, Ohio plastic pipe producer.

H. Edward Rodgers joined **Chicago Molded Products Corp.** as sales rep. for the Custom Molding Div.

Russell W. Buchanan appointed prod. control mgr. **Cary Chemicals Inc.,** Flemington, N. J. mfr. of polyvinyl chloride resins and compounds.

New reps.

Muro Plastics Co., 801 Spring St., Seattle, Wash., appointed by **Modern Plastic Machinery Corp.,** Clifton, N. J. as exclusive rep. in the northwestern states, Alaska, Hawaii, and parts of Canada . . . **Francis Shaw Ltd.,** Burlington, Ont., Canada, appointed exclusive Canadian rep. by **Thoreson-McCosh Inc.** for the company's line of hopper-dryers, loaders, and shear-way granulators. . . .

Berton Plastics Inc., New York, N. Y., named as distributor for **The Dow Chemical Co.**'s styrene monomer. . . . **Kreidl K.G.,** Vienna, Austria, appointed by **Fragrance Process Co.,** New York, as European rep. for its process of impregnating PE film and other products with aromas. . . . **Seiberling Rubber Co.** appointed **Graves T. Lewis,** Atlanta, Ga., and **B. Elmer Steele,** Knoxville, Tenn., as Southern sales reps. for its Seilon rigid thermoplastic sheet materials.

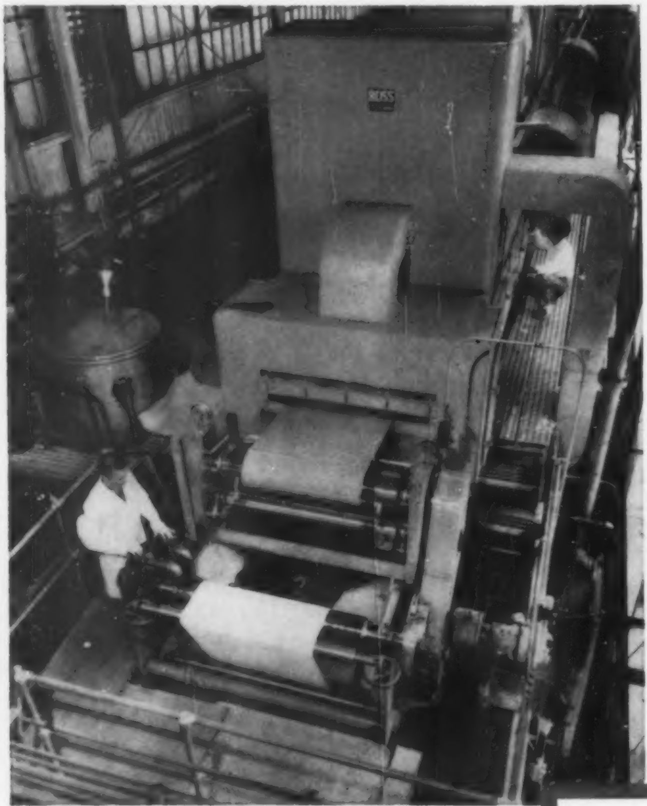
Corrections

"How to Choose the Correct Colorant" (MPl, Apr. 1960, p. 82): Light resistance refers to masstone and tint (third and fourth columns in green portion of chart) only, and not to heat. "Dyers" (bottom of first column) should read "dyes."

"Modern Plastics Chart of Self-Extinguishing Plastics Materials—II" (MPl, Apr. 1960, pp. 93-98): Correct spelling for the following manufacturer's name is: Panelyte Div., St. Regis Paper Co.

"Research labs" (MPl, Apr. 1960, p. 158): Booklet described covers only activities of DeBell & Richardson Inc., is not a summary of all research laboratories available to plastics industry.—**End**

ROSS/WALDRON
Saturator·Treater Line



Installation at Richardson Company, Melrose Park, Illinois

STANDARD EQUIPMENT *Engineered* FOR QUALITY PRODUCTION

Here is a typical Ross/Waldron Saturator-Treater Line "in production". The standard Waldron Saturator is set to precisely apply just the right amount of saturant to the web—the standard Ross Oven removes the moisture through precisely controlled heating zones. Ross and Waldron team their standard units and special engineering skills to give you top quality production.

Your inquiry will receive prompt attention. To save additional time, it would be helpful if you outline your specific problem.

Typical Applications for Ross/Waldron Saturator-Treater Lines

- Decorative laminates such as table tops, wall covers, counter tops, etc.
- Industrial insulations such as rods, bushings, gaskets, tubes, panels, and also latex impregnated papers, etc.

Current users of Ross/Waldron Saturator-Treater Lines

General Electric Company
Westinghouse Electric & Eng. Co.
Formica Corporation
Synthane Corp.
Continental Diamond Fibre Corp.
Taylor Fibre Corp.
St. Regis Paper Co.
Consolidated Water Power & Paper Co.
Arborite Co. Ltd.
Latex Fibres Industries
Endura Corp.
Johnson & Johnson
Fabricon Products
Richardson Company

WALDRON-HARTIG DIVISION
Midland-Ross Corporation
Box 791 New Brunswick, N. J.

"Technical competence in web process machinery"

M-R MIDLAND-ROSS CORP.

WM-460

Effective May 31st, the name of Enjay Company, Inc. changed to Enjay Chemical Company, a division of Humble Oil & Refining Company. Enjay Chemical Company will continue to serve modern industry with a complete line of petrochemicals, including Butyl rubber, solvents, resins, plastics, and additive compounds for fuels and lubricants. As a division of Humble Oil & Refining Company, the company is determined to become even more important in the growing petrochemical field.

As the pioneer in petrochemicals, and a leader in the marketing of chemical raw materials, it has always been the policy of Enjay to help customers develop new products and improve existing ones. Enjay now has ten sales offices – including the new one recently added at Houston, Texas – standing ready to offer immediate handling of product orders and requests for technical service. Strategically located distribution points also offer benefits of prompt deliveries.

Enjay Chemical Company looks forward to giving its thousands of customers continued and unequalled technical service . . . backed by one of the world's largest research organizations.

HOME OFFICE:
15 West 51st Street, New York 19, N. Y.

OTHER OFFICES:

Akron	*Boston*	*Charlotte*
Chicago	*Detroit*	*Houston*
Los Angeles	*New Orleans*	*Tulsa*

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY

ENJAY
PETROCHEMICALS

CLASSIFIED ADVERTISEMENTS

EMPLOYMENT • BUSINESS OPPORTUNITIES • USED OR RESALE EQUIPMENT

Machinery and Equipment for sale

MOST MODERN PACKAGING and processing machinery. Available at great savings. Baker Perkins, W & P. and Day Double Arm Steam Jacketed Heavy Duty Mixers—25, 50, 75, 100, 150 and 200 gal. capacities. Devine 650 gal. Jacketed Double Spiral Mixer. Day 2½ gal. MDA Mogul D.A. Vac Experimental Mixer. Fitzpatrick Models D, K-7 and K-8 Stainless Steel Comminuters, Werner & Pfleiderer 3,000 gal. and 3,500 gal. Jacketed Double Arm Mixers. Stokes Models R, RB-2 and DD2 and Eureka Tablet Machines. Colton 2RP, 3RP, 3B, 5½ T Tablet Machines. Mikro Pulverizers, Models 1SH, 2TH, 3TH and 4TH. Day, Robinson 50 to 10,000 lbs. Dry Powder Mixers. Jacketed and Unjacketed. Also wood and enamel. Day Imperial 75 gal. Double Arm Mixer, Sigma Dispersion Blades. Package Machinery, Hayssen, Scandia, Wrap King, Campbell, Miller Wrappers. Pneumatic Scale Automatic Carton Feeder, Bottom Sealer, Wax Liner, Top Sealer with Interconnecting Conveyors, Standard Knapp, A-B-C, Ferguson Carton Sealers. Union Standard Equipment Company, 318 Lafayette Street, New York 12, N.Y. Phone: CAnal 6-5334.

FOR SALE: 1—Baker Perkins 100 gal. Sigma blade Mixer; 1—Baker Perkins size 16 TRM 150 gal. double arm Vacuum Mixer; 1—No. 1 Ball & Jewell Rotary Cutter; 2—Mikro Pulverizers, S.S. Bantam, #1SH; 6—Stokes Model DD2, DS3, D3, and B2 Rotary Preform Presses. Also: Sifters, Banbury Mixers, Powder Mixers, etc., partial listing; write for details; we purchase your surplus equipment. BRILL EQUIPMENT CO., 35-55 Jabez St., Newark 5, N. J. Tel: Market 3-7420.

FOR SALE: Ovens, Grinders, Powder Mixers, Injection Molding Machine 1 oz. to 60 ozs. never used and used. Two-head Bottle Blowing Machine. Acme Machinery & Mfg. Co. Inc., 20 South Broadway, Yonkers, N.Y. YOnkers 5-0900. 102 Grove Street, Worcester, Mass., PLeasant 7-7747.

FOR SALE: Stainless reactors or resin Kettles: 3500, 2200, 1900, 1300, 1000, 750, 500, 350 gal. jktd. and agit. Baker-Perkins dbl. arm mixers: 200, 100, 50 gal. capacity, steel or stainless. Perry Equipment Corp., 1429 N. 6th., Phila. 22, Pa.

FOR SALE: Hydraulic press 48" x 48", ten openings, 3" daylight, 250 tons, with pumps and controls, installed in our plant. Reply Box 6554, Modern Plastics.

FOR SALE: Plastic Laminating Machines, Hydraulic, all-electric & water cooled: equipped with accessories, ready for production: 1. Size 10" x 12" with four openings: 2. Size 5½" x 9" with four openings; 3. Size 6" x 6", two openings, Carver, P. O. Box 875, Milwaukee, Wis.

HYDRAULIC PRESS: Two 40" x 40" steam heated platens for 2,000 P.S.I., upacting 14" dia. ram; 14" daylight opening, 14" stroke. Available with Barnes Hydraulic Pump for 2,000 P.S.I. complete with 4 way valve and 5 H.P. motor mounted on tank. Excellent condition. Reasonably priced at $3,000. Reply Box 6561, Modern Plastics.

HYDRAULIC PRESS: R. D. Wood 2280 ton Laminating Platen Type. Six Rams, 18" Dia. Heating Platens 24" x 144". 10" Stroke. Morey Machinery Company, 383 Lafayette St., N.Y. 3, N.Y. AL 4-6560.

FOR SALE: One Cumberland #0 Plastics Granulating Machine equipped with 2HP, 1800RPM, 3/60/220/440 open ball bearing motor and flexible coupling. Used very little, like new. $350.00 FOB St. Louis, Missouri. Celucoat Corporation, 6161 Maple Ave., St. Louis, Missouri.

FOR SALE: 3 Ball & Jewell rotary cutters, 10, 7½ and 2 HP; 1 Stokes model 235—50 ton automatic molding press; 1 M P M 2½" electrically heated plastics extruder; 3 compression molding presses 200, 150 and 100 tons; 3 Stokes preform presses models FR and 280-C. Chemical & Process Machinery Corp., 52-9th St., Brooklyn 15, N. Y. HY 9-7200.

FOR SALE: Two Reed Prentice Inj. Molding Machines, model 10D—12 oz. (1954) complete with instruments, controls, etc. for immediate removal. Both machines are in excellent condition and priced reasonably. Call, write, or phone for appointment to see in operation before removal. Rogers Plastic Corporation, West Warren, Massachusetts. HE 6-7744. Ask for John Krach.

FOR SALE: MPM 3½" wire covering Extruder. New ¾" Plastic Extruder. Other sizes up to 6". Two new Farrel Birm. 14" x 30" two roll Mills, also Seco 6" x 12" and 8" x 16", 2-Roll Mills and Calenders, and other sizes up to 60". Watson-Stillman 240 ton, ten 24" x 56" platens. Baldwin-South. 200 ton Semi-automatic transfer Molding Press. Baldwin-South. 150 ton downstroke 48" x 40" platens. Stokes Standard 150 ton Semi-automatic. French Oil 120 ton self-contained. 120 ton Upstroke, 29" x 21" platens, 10" stroke. 60 ton Farquhar 50" x 50" platens, 30" stroke. Stokes 50 ton Semi-automatic 22" x 12" platens. 50 ton Birdsboro 24" x 20" platens. 30 ton Birdsboro 21" x 14" platens. Hydraulic Pumps and accumulators. Despatch elect. Heated Ovens and other types. New ¾ oz. Bench Model Injection Molding Machines. Van Dorn 1 oz. and 2 oz., other sizes to 100 oz. capacity. Baker-Perkins and Day Jacketed Mixers. Plastic Grinders. Stokes RD3 Rotary-Preform Tablet Machine, also single punch ½" to 4". Send for listings. We buy your surplus machinery. Stein Equipment Company, 107-8th St., Brooklyn 15, New York.

CHECK THESE SPRING VALUES: 60 oz. HPM Injection Molding Machine, late type, inspect on location. Complete with all controls equipped with exact weight feed and mold coolers. 600 Ton Adamson Multi-opening Hydraulic Press. 26" diameter chrome-plated ram, slab side construction. Press contains nine 42" x 42" platens. New 1951. Stokes Model "R" and Colton Model 4½ T, single punch Tablet Presses. Individually motor driven. NRM 1½" Electrically Heated Plastic Extruder. Complete with wheelco panel board and Vari-speed drive. 75 Ton Baldwin-Southwark Transfer Molding Press, completely self-contained with all operating controls. Cumberland #½ Rotary Scrap Cutter, complete with 10 HP motor. Cumberland #1½ Rotary Scrap Cutter with 3 HP motor. 2 oz. Watson-Stillman Vertical Injection Molding Machine. Completely self-contained with all operating and heat controls. 2½ oz. Van Dorn Full Automatic Injection Molding Machine. Also in stock: Van Dorn 1 oz. lever-operated Injection Molding Machine, Van Dorn 2 oz. Semi-automatic Injection Molding Machine, new 1955, NRM 2½", Royle 3¼", Hartig 3¼" and Adamson 6" Extruders. Also a complete line of Blenders, Mixers, Scrap Cutter, etc., for the Plastic and Rubber Industries. WHAT DO YOU NEED? WHAT DO YOU WANT? We Will Finance. Johnson Machinery Company, 683 Frelinghuysen Avenue, Newark 12, New Jersey. Bigelow 8-2500.

FOR SALE: Stokes 200 ton press bar control $4000.00. 4 Barry Button Machines $450.00 each. Molded Plastic Button Corp., 1333 Broadway, N.Y. 18, N.Y. LOngacre 5-4427.

Machinery Wanted

WANTED TO BUY: Used injection molding machines, oven, granulators. One machine or complete plant. Acme Machinery & Mfg. Co., Inc., 20 South Broadway, Yonkers, N.Y. YOnkers 5-0900. 102 Grove Street, Worcester, Mass. PLeasant 7-7747.

WANTED: One or more 150 and 200 Ton Stokes Compression semi-automatic presses. Reply Box 6546, Modern Plastics.

WANTED: Positive matched metal dies, approximately 6-10" deep, 10-15" long and 6-10" wide; hardened steel construction, for reinforced plastics evaluation. Reply Box 6548, Modern Plastics.

WANTED: Used Watson-Stillman 4V-100 vertical injection molding machine. Forward photographs and complete data including price to Plasteck, Incorporated, Poteau, Oklahoma.

Materials for sale

FOR SALE: Black Reprocessed LINEAR P/E also other selected colors for extrusion or blow molding at .23/lb. Gold-Mark Plastic Compounds, Inc., 4-05 26 Ave., L.I.C., New York, RA 1-0880.

WE SPECIALIZE in "BLACKS." High Impact Styrene, Utility Black. Medium Impact Styrene, Utility Black. General Purpose Styrene, Utility Black. General Purpose Styrene, High Lustre Black. Polyethylenes, Black. Butyrate, Black. The Larger the Order, The Lower the Price. Erie Plastics Company, Inc., 1221 Walnut St., Phone GL 2-2503, Erie, Pa.

FIBREGLASS SURFACING MAT: 500,000 sq. ft. of unused material in rolls 600 ft. to 900 ft. long and 18 in. wide. Samples upon request; write or call. Plastic Trading Company, 1006 Prudential Bldg., Buffalo, New York, WA-4926.

Materials Wanted

WANTED: Urgently need any quantity of colored and crystal Butyrate Scrap. Sheet trim, Purgings, Parts, Reground. Claude P. Bamberger, Inc., Ridgefield Park, N.J., HUbbard 9-5330.

WANTED: Plastic scrap. Polyethylene, Polystyrene, Acetate, Acrylic, Butyrate, Nylon, Vinyl, George Woloch, Inc., 514 West 24th Street, New York 11, N. Y.

WANTED: GOOD clean lots of Hi-Imp.; Med. Imp.; and Gen. Purp. Styrenes, Regrind or Pellets, straight colors or mixed colors. Top prices paid. Erie Plastics Co., Inc., P.O. Box 1068, Erie, Pa.

GET THE TOP MONEY FOR PLASTIC SCRAP: Now paying top prices for all thermoplastic scrap. Wanted: polystyrene, cellulose, acetate, vinyl, polyethylene, butyrate, acrylic, nylon. All types and forms including rejects and obsolete molding powders. Fast action wherever you are located. WRITE, WIRE, TODAY! Reply Box 6556, Modern Plastics.

PLASTIC SCRAP WANTED: Styrene, Acrylic, Polyethylene, Butyrate, Acetate, Vinyl, Nylon, Etc. WE PAY TOP DOLLAR for your plastic scrap and surplus molding powders in any form. We also supply molding powders to the plastic industry at reasonable prices. Please contact for information. Philip Shuman & Sons, 571 Howard Street, Buffalo 6, N.Y. MA. 3111.

THERMOPLASTIC SCRAP bought, sold and traded, all types. Plastic Trading Co., 1006 Prudential Bldg., Buffalo 2, N.Y. WA 4926.

WANTED: Plastic of all kinds—virgin, reground, lumps, sheet and reject parts. Highest prices paid for Styrene, Polyethylene, Acetate, Nylon, Vinyl, etc. We can also supply virgin & reground materials at tremendous savings. Address your inquiries to: Gold-Mark Plastics Compounds, Inc., 4-05 26th Ave., Long Island City 2, N.Y. RAvenswood 1-0880.

(Continued on page 262)

(Continued from page 260)

WE ARE IN THE MARKET for all types of thermoplastic scrap; also surplus or obsolete lots of reprocessed or virgin molding powders. D. Linder Plastics, Inc., 1825 Raspberry St., Erie, Pa. Phone GLendale 4-8146.

Molds wanted

OVERSEAS PLASTIC MOULDER having compression and injection moulding machines of 50/100 tons and 8/10 ounces wants permanent arrangement for getting steel moulds of electrical accessories, household and domestic articles on rental basis. Moulds will be returned in good condition. Those interested apply with photographs and terms of business to Box 6547, Modern Plastics.

MOLDS WANTED: Interested in purchasing injection or compression molds for consumer products, parts, novelties, or related items. Reply Box 6559, Modern Plastics.

WANTED: Multi Cavity Ash Tray Mold. Submit Samples or Drawings, Price, Condition. Reply Box 6574, Modern Plastics.

Molds for sale

FOR SALE: Complete set of injection molds for new, unique and popular priced Record Holder (45 rpm). Single cavity base mold. Double cavity side mold. Perfect condition, practically new. For more information, contact S. Berlin, The Malls Co., 3031 James Street, Baltimore 30, Maryland.

Help wanted

PLASTIC-EXTRUSION ENGINEERS: Initiative, incentive and some experience in processing and extrusion techniques preferred. New openings in technical department created by expansion program of a large, reputable polyethylene film producer. Salary commensurate with ability. Send resume to: Plastic Horizons, Inc., 1 Erie St., Paterson, N.J.

POLYESTER RESIN CHEMIST with B.S., M.S. or Ph.D. degree needed for expanding research department of progressive company. Experience in the field of unsaturated polyester resins is desired. Original work will be encouraged. Liberal benefits. Please send complete resume including present salary to: Dr. Jay E. Meili, Director of Polymer Development, Freeman Chemical Corporation, 211 East Main Street, Port Washington, Wisconsin.

TECHNICAL LABORATORY: An excellent opportunity for a young man to join the expanding Plastics Division of Spencer Chemical Company. This man should have a degree in engineering or a related field with experience in the field of thermoplastics. He will perform studies on extrusion and molding of polyolefins and nylon and will have some field technical service responsibilities. In reply, please send detailed resume to: Personnel Manager, Spencer Chemical Company, 610 Dwight Building, Kansas City 5, Missouri.

TECHNICAL SERVICE engineer: Should have experience in the use of polyester resins in the production of reinforced plastics. This position involves considerable customer contact in addition to some work in our laboratories. This company is well established in the synthetic resin field and is the chemical subsidiary of the H. H. Robertson Co. and offers a generous line of fringe benefits. Address replies to: Mr. K. A. Schafer, Freeman Chemical Corp., 211 E. Main Street, Port Washington, Wisconsin.

PIONEER MANUFACTURER of Epoxy Compounds and Epoxy Color Pastes needs representatives to follow up large number of fine sales leads in various parts of country. Write The Clinton Company, 1210 Elston Ave., Chicago 22, Illinois.

SUPERINTENDENT: Injection Molding. Well known established firm located in Metropolitan New York wishes to employ an energetic and qualified person capable of assuming complete charge of its molding and maintenance operation. Prefer a person having knowledge of new molding materials and techniques and ability to train department personnel. Opportunity to progress financially. Benefit program consists of company-paid major medical insurance and pension plan. All inquiries will be kept in confidence. Please send resume ad salary requirements to Box 6551, Modern Plastics.

PLASTICS BLOW MOLDING Foreman supervisor: Experienced on latest equipment techniques and materials. Opportunity with growth company in Metropolitan New York. State full experience and salary requirements. Chanal Plastics Corporation, 63-20 Austin St., Rego Park 74, New York.

SUPERVISOR: Product and Process Engineering: Position open for Mechanical Engineer with main experience in nylon injection molding and some experience in compression molding. To handle process development within the Plant and some travel and customer relations with regard to new product development. Responsible for supervision of design tooling and quality control. Age 30 to 45 years. Salary $12,000 to $15,000. Reply Box 6553, Modern Plastics.

SALES—FLEXIBLE PACKAGING: Outstanding opportunity for a self-starter to grow with expanding Plastics Division of well established Corporation which has diversified into packaging. Require minimum 5 years field sales experience, preferably Southern areas, in unsupported film and coated substrates: paper, paperboard, film, foil. Do not apply unless you have this background, possess a technical aptitude for flexible packaging, plus a genuine desire for advancement by consistent, intelligent application. Southeastern location. Starting salary commensurate with experience. Please forward detailed resume of personal history, experience, and salary requirements to Box 6555, Modern Plastics.

COLOR CHEMIST IN Thermoplastics to develop as color chemist as well as expand into general polymer studies in new thermoplastics field at modern, progressive company. B.S., M.S. or Ph.D. Level will be considered. Please submit a detailed resume; replies will be held in strict confidence. J. H. Saunders, Director of Research, Mobay Chemical Company, (Associate company of Monsanto Chemical Co.) New Martinsville, West Virginia.

DEVELOPMENT ENGINEERS: NRM has exceptional opportunity for top-quality project engineers. Substantial experience in blow molding or extruder design can lead to rapid advancement. Please send resume of education, experience, and salary requirements to E. E. Heston, Manager, Extruder Division, National Rubber Machinery Corp., 47 W. Exchange Street, Akron 8, Ohio.

SALESMAN: Experienced in virgin and reprocessed plastics to eventually take over as Sales Manager for a reprocesser. Excellent opportunity for the right man. Salary open. Operate generally in the Metropolitan New York-New Jersey area at present. Reply Box 6560, Modern Plastics.

PROGRESSIVE PLASTIC sales representative wanted in New York and New Jersey areas. Please reply Box 6566, Modern Plastics.

PRODUCT MANAGER (Technical Market Specialist) Glass Fiber Reinforcing Mats and Related Materials. The man we are seeking will be in charge of all sales and marketing of a new type of business for a division of a substantial company located in the middle west. He should have experience in reinforced plastics or reinforcing media. A college degree in chemistry or chemical engineering desirable. The man selected will report to the Division Manager. He will develop technical product knowledge, call on key accounts, plan promotional programs, etc. An attractive salary will be arranged and will include a substantial incentive. Preferable age 30-45. Please send your resume in complete confidence to Dept. 17-MP, Box 226, Church Street Station, New York 8, N.Y.

VINYL EXTRUSION SALES: Excellent growth opportunity for salesman experienced selling vinyl extrusions to various markets. Headquarters Boston area. Some travel required. Send resume with full details and salary requirements to: C. W. Erickson, The Borden Chemical Company, Division of The Borden Company, 350 Madison Avenue, New York 17, N.Y.

RESEARCH ENGINEER PLASTICS: New position in Research and Development offers unusual opportunity for engineer familiar with plastics evaluation field. Location is a new plastics laboratory to be completed shortly at Ponca City, Oklahoma. We need a graduate engineer with minimum of five years experience in plastics to help organize and conduct research program. This position will require a good knowledge of processing evaluation and the effects of different polymer structures on used properties. Send resume of background and salary requirements to: Personnel Relations Department No. 1, Continental Oil Company, Ponca City, Oklahoma.

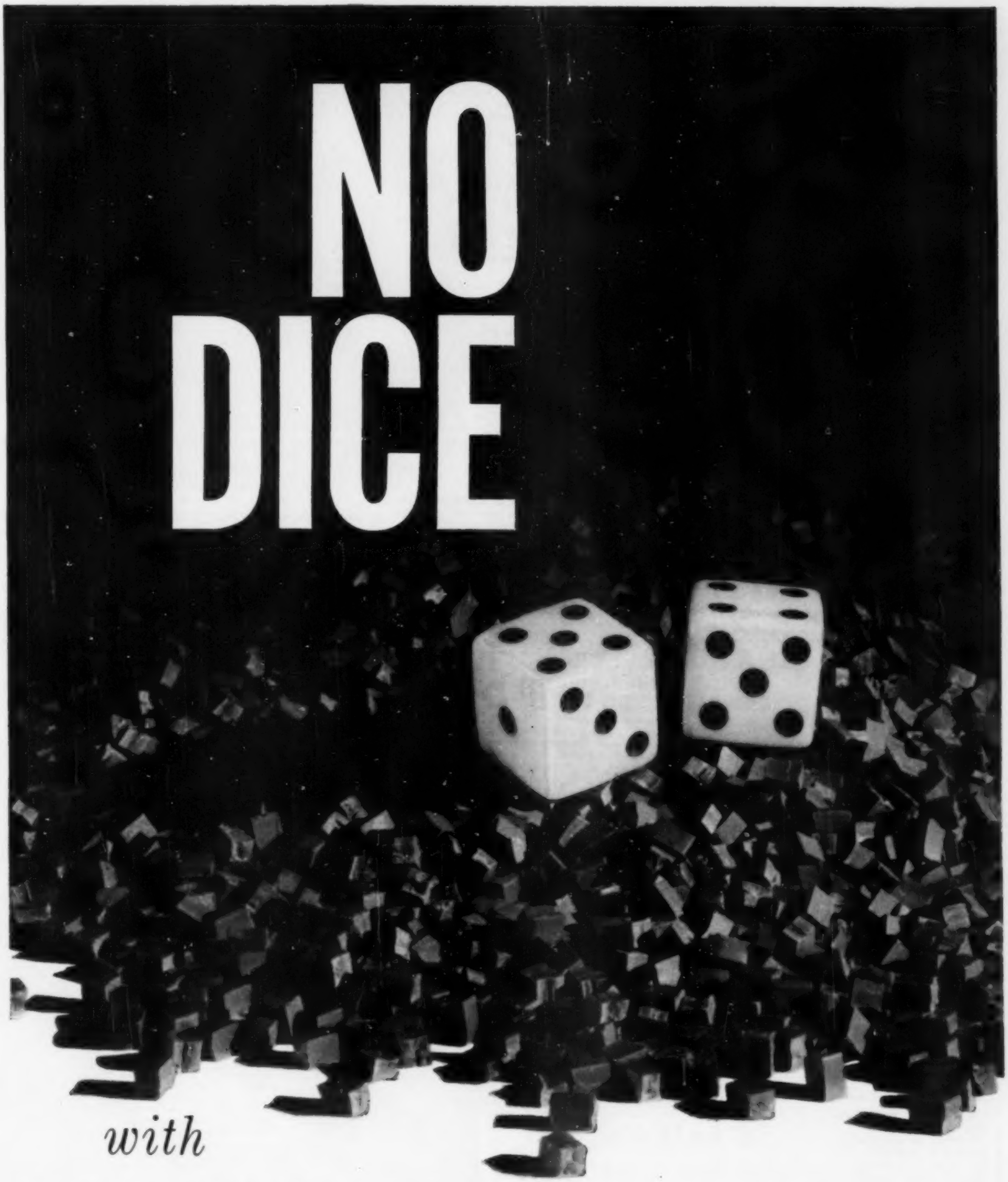
PLASTICS ENGINEER: Experienced in designing compression molds, estimating, and capable of taking charge of compression molding department. Philadelphia area. Reply Box 6569, Modern Plastics.

PLANT MANAGER: Expanding Chicago corporation has exceptional position for man with sheet extrusion and vacuum forming experience. Man should have good extrusion background and ability to handle production problems. This is a permanent position offering growth and developmental opportunities. Good salary commensurate with ability. Excellent working conditions. Replies confidential. Reply Box 6563, Modern Plastics.

DEVELOPMENT ENGINEER: Immediate opening in the product and process development section. Previous experience in slush molding and rotocasting of plastisols required, preferably some footwear experience. Also a working knowledge of injection molding and heat sealing would be beneficial. Excellent opportunity in connection with a department to manufacture a new line of products. Contact Mr. R. Hahn, Chief Engineer, O'Sullivan Rubber Corporation, Winchester, Virginia.

PRODUCT ENGINEER: Leading manufacturer of vacuum bottles and lunch kits has an important opening for a management-minded product engineer. We prefer an engineer who has knowledge and experience in the manufacture of light gauge steel, plastics, and aluminum products. He should be able to establish manufacturing specifications and tolerances and engineer research designs for high speed production. If you are interested in personal development, advancement, and long-range security and if you want a job where your accomplishments will show and will be rewarded, send resume of experience, expected salary, education, and references (previous employers preferred). All replies treated confidentially. Aladdin Industries, Incorporated, Box 7225, Nashville, Tennessee.

(Continued on page 264)



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(Continued from page 262)

PLASTICS APPLICATION ENGINEER: We are looking for a Chemical Engineer with 2 to 5 years experience in the application of thermoplastics. This position offers an opportunity to join the Research and Development Division of our progressive and growing company. Please send full details in confidence to: Personnel Director, Foster Grant Co., Inc., Leominster, Mass.

AGGRESSIVE SALES organization offers concentrated coverage of the greater Chicago area for a quality product line. CONTACT: Mr. Lloyd Qually, c/o Application Engineering Corporation, 3811 Podlin Drive, Franklin Park, Illinois. Phone: POrter 6-5653. Many years experience engineering for production efficiency and economy in the plastics industry.

PLASTIC SALES ENGINEER: We are building an organization to commercialize the new plastics being developed by our research program. We need an effective and aggressive sales engineer to help introduce our materials to customers. Ability to work with product designers, plastic specialists, molders, extruders, and purchasing agents essential. Five to ten years experience with thermoplastics, their molding, extrusion, and fabrication desired. Preferably includes acrylic background. This is a position of major responsibility offering high challenge and excellent opportunity for a rewarding future. Sherman L. Tibbetts, Personnel Manager, J. T. Baker Chemical Co., Phillipsburg, N. J.

Situations wanted

PLASTIC AND ORGANIC Chemical Sales: B.S. Chemical Engineering, Age 27. Five years successful, high volume industrial sales in the chemical industry. Good with new or rapidly growing products and ideas. Best references. Prefer commission basis in Chicago or New York area. Resume on request. Reply Box 6545, Modern Plastics.

MANUFACTURER'S REPRESENTATIVE: Seeking molding and extrusion lines. Covering all six New England States, calling on O.E.M. and industrial distributors. Technical knowledge of all thermosets and thermoplastics. Years of experience selling industrial plastics. Excellent sales record, complete knowledge of market. List materials processed, methods and if custom or standard products. Reply Box 6549, Modern Plastics.

CHEMICAL ENGINEER—12 years of product and process development experience in plastics and coating. Successfully handled broad responsibilities from the original concept through the laboratory, equipment design, production and sales. Thrives on problems and challenge. Age 34, family. Requires location within 50 miles of N.Y.C. Reply Box 6552, Modern Plastics.

EXPANDABLE POLYSTYRENE Engineer: 6 yrs. exp., complete plant set-up. Press, machine, multi-cavity mold design. Model exp. work; knowledge of piping and wiring for automatic presses; developer of colorfast dying. Also 10 yrs. exp. in vac. forming and fabricating of thermo plastics. Design and development exp. equiv. to engineer; no degree. Presently employed as designer and trouble shooter for 3 shift plant. Will relocate. Reply Box 6557, Modern Plastics.

CANADIAN SALES—Capable, experienced, successful in sales both U.S. and Canada. Thorough knowledge of thermosetts and thermoplastics. Graduate M.E., registered professional engineer, family, age 31. Presently employed in Detroit area by one of the larger polypropylene producers. Canadian sales desired with base activities in Toronto. Reply Box 6562, Modern Plastics.

ENGINEER-PLANT MANAGER: 15 years technical experience. Mold design; estimating; development; job setup; production supervision. Desire compression and injection combined operation. Thrive on challenges; quick mold and tool deliveries; job cost reduction. Reply box 6564, Modern Plastics.

GENERAL MANAGER or Plant Manager, 37, BS, MBA, 17 years experience includes shop work, product and molding engineering, production control, purchasing, cost control, methods and systems analysis in the blow molding, injection, extrusion and rotation molding fields. Desirous of obtaining position with progressive organization. Reply Box 6565, Modern Plastics.

URETHANE FOAM SPECIALIST: Practical and theoretical experience all phases foam production-plant and machine design, formulations, testing production operation particularly ester and "one-shot" ether foams. Able to start-up, train personnel and maintain complete production operation. Seeking new top level connection with manufacturer and/or new material supplier. Reply Box 6568, Modern Plastics.

CHEMICAL ENGINEER: 34, twelve years diversified experience; thermoplastics calendering extrusion, and laminating; industrial coatings formulating; elastomers. Strong background in product and process development technical service, market development, sales promotion, production, administration. Patents. Currently employed AAAA Company in responsible supervisory position where opportunity is limited. Reply Box 6570, Modern Plastics.

SALES—SALES MANAGEMENT: Now employed. Ten years experience in flexible packaging sales. Includes Polyethylene, Cellophane and Coated Polyolefins for leading manufacturer. Responsible for $1,000,000. sales annually. Desires challenging opportunity with reliable and fast moving manufacturer. West Coast location preferred. Possesses intelligence, integrity and energy. Presently located Midwest. Will relocate. Reply Box 6572, Modern Plastics.

PLANT SUPERINTENDENT: 22 years experience; plant set-up, mold designing, toolroom supervision injection molding, extrusion and blow molding. Desires to relocate with company where his knowhow can be fully utilized. Reply Box 6575, Modern Plastics.

Miscellaneous

WANTED: Plastic Molding Operation. Injection, Phenolic or Fiberglas Molding. Outright purchase or part. Present management preferably retainable. Reply Box 6544, Modern Plastics.

PRODUCTION ITEM NEEDED: By Sandwich Panel Manufacturer. Contact: Kormac Panels direct, Grand Saline, Texas, or Box 10224, Dallas, Texas.

FOR EXPORT: Button dies and miscellaneous molding equipment available for export. Write Merit Plastics, 30 Lincoln Place, Lynbrook, N.Y.

SUCCESSFUL SALES ORGANIZATION Available for Exporters to Benelux. Here's a rare opportunity for someone seeking a distribution set-up in the Benelux area! For 12 years, with great success, our firm has represented one of the largest U.S. producers of plastic materials. Only because they are setting up their own organization, we will lose one of our major products. We are seeking new plastic and chemical lines. Excellent references. Offices in Brussels and Rotterdam. Write IMEXIN S.A., 5, Av. de Broqueville, 15, Brussels, Belgium.

COMPLETE METALLIZING plant for sale. Will set you up at great savings. Reply Box 6550, Modern Plastics.

SEEK CONTACT with those experienced in producing plastic denture material, and, the moulding or manipulation of that material. Also, moulding of flexible Vinyl. Those interested to undertake production of a model of a gadget that would be prescribed by physicians. The gadget, a generic idea that has merit. A patentable idea. An unusual opportunity. Reply Box 6558, Modern Plastics.

FORMALDEHYDE: Technical Collaboration/Investment sought in India; guaranteed sale. Reply Box 6567, Modern Plastics.

LICENSE SOUGHT for the European market. I am looking for items that can be produced from P.V.C. by rotational or slush molding. If possible these items should be protected (patented) for the European market under a license arrangement or participation by American Companies in Germany. Reply Box 6571, Modern Plastics.

PLASTICS: If you are a volume user of injection molded parts with the usual quality, price and delivery problems, get in touch with me on how you may obtain a substantial interest in a profitable small molding company with little or no investment. We are very heavy in engineering and production know-how. Fast equipment. Location—Washington, D.C. Area. Reply Box 6573, Modern Plastics.

RATES FOR CLASSIFIED ADVERTISING

All classified advertisements payable in advance of publication

Closing date: 10th of preceding month, e.g., July 10th for August issue
Per inch (or fraction) .. $30.00; each 3 inches or fraction (in border) $15.00 extra

Situations Wanted Ads ... 1/3 of above rates

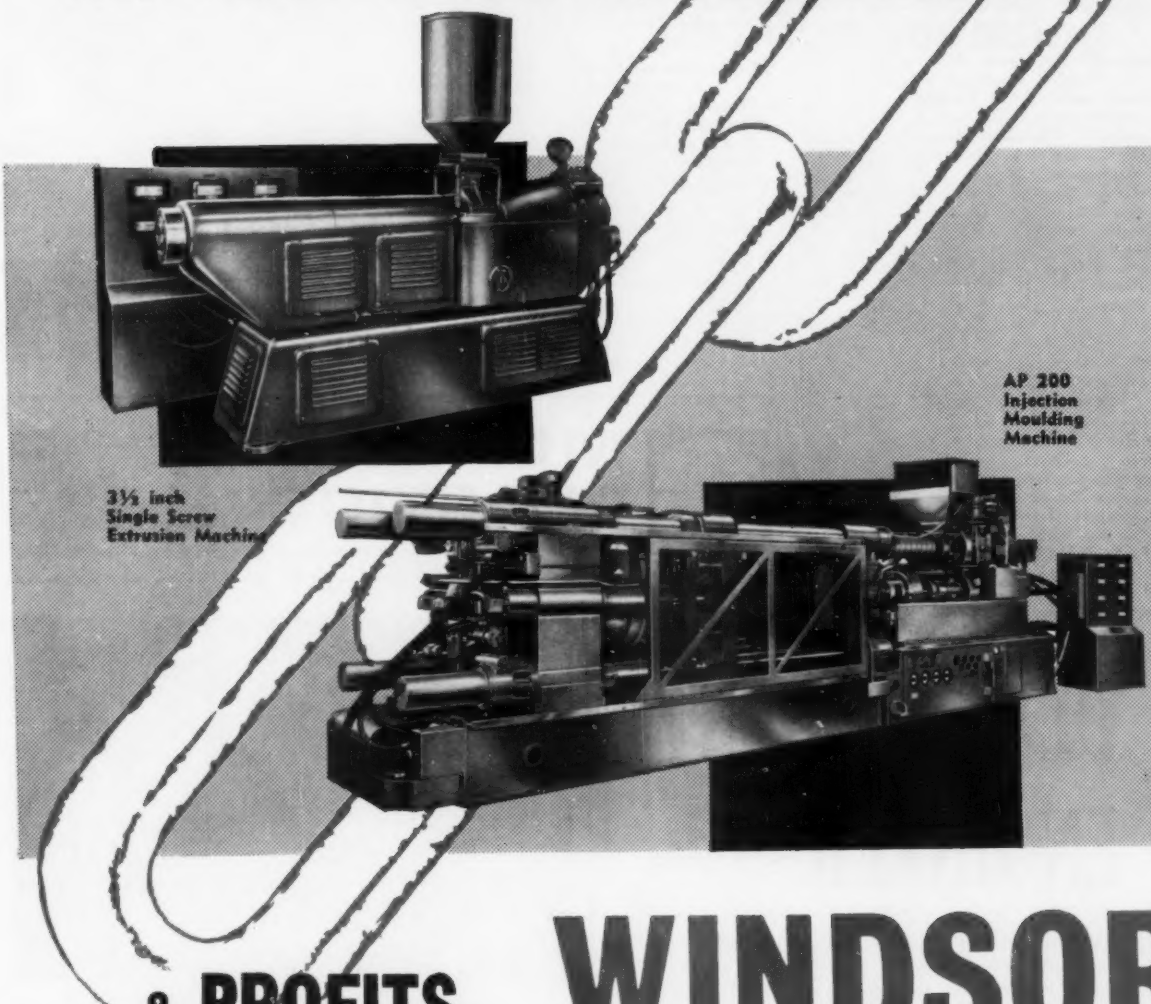
For purpose of establishing rate, figure approximately 50-55 words per inch. For further information address Classified Advertising Department. Modern Plastics, 575 Madison Avenue, N. Y. 22, N. Y. Modern Plastics reserves the right to accept, reject or censor classified copy.

INDEX OF ADVERTISERS

Distribution of this issue: 35,700 **JUNE 1960**

(Continued on page 268)

the Link Between PLASTICS . . .



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SERVING THE WORLD'S PLASTICS INDUSTRY — Windsor — PLASTICS MACHINERY — TRADE MARK

(Continued from page 266)

MODERN PLASTICS

A BRESKIN PUBLICATION

PUBLISHED BY BRESKIN PUBLICATIONS INC. 575 Madison Avenue, New York 22, N. Y.

EDITORIAL

Chaos in dinnerware

In a field in which there is good demand for quality products, and for which there is an obviously fabulous future—melamine dinnerware—it is amazing to watch pricing policies that can only result in loss of prestige and profit.

More amazing is the fact that the cut-price condition is being generated within the molding industry itself.

The whole success of melamine tableware, to date, has been based on better-than-standards quality. Price cuts for volume purposes can lead only to lower quality products. This, in turn, can lead only to loss of distributor and public goodwill and to lower profits. Again, this would mean that less money would be available from profits for sales expansion, for promotion, and more important, for development and research directed toward still better quality.

With the big new developments in decorating methods, as outlined in this issue (pp. 87-91), with new opportunity to compete with other materials in beauty and quality, with a constantly expandable market, we are convinced that those in the melamine dinnerware field should take thought to pricing policies now, before chaos is compounded to the financial and market loss of their whole industry.

This sore condition, in one segment of the plastics industries, if allowed to fester further, causing public dissatisfaction through the lowering of dinnerware quality, can affect every other segment of the plastics industries and can bring loss of prestige and profits to the whole industry.

The price-cutter has always been with us in all industries. To allow him to dictate or even to influence marketing policies —policies which can only snowball into disaster—is absurd.

A clarification

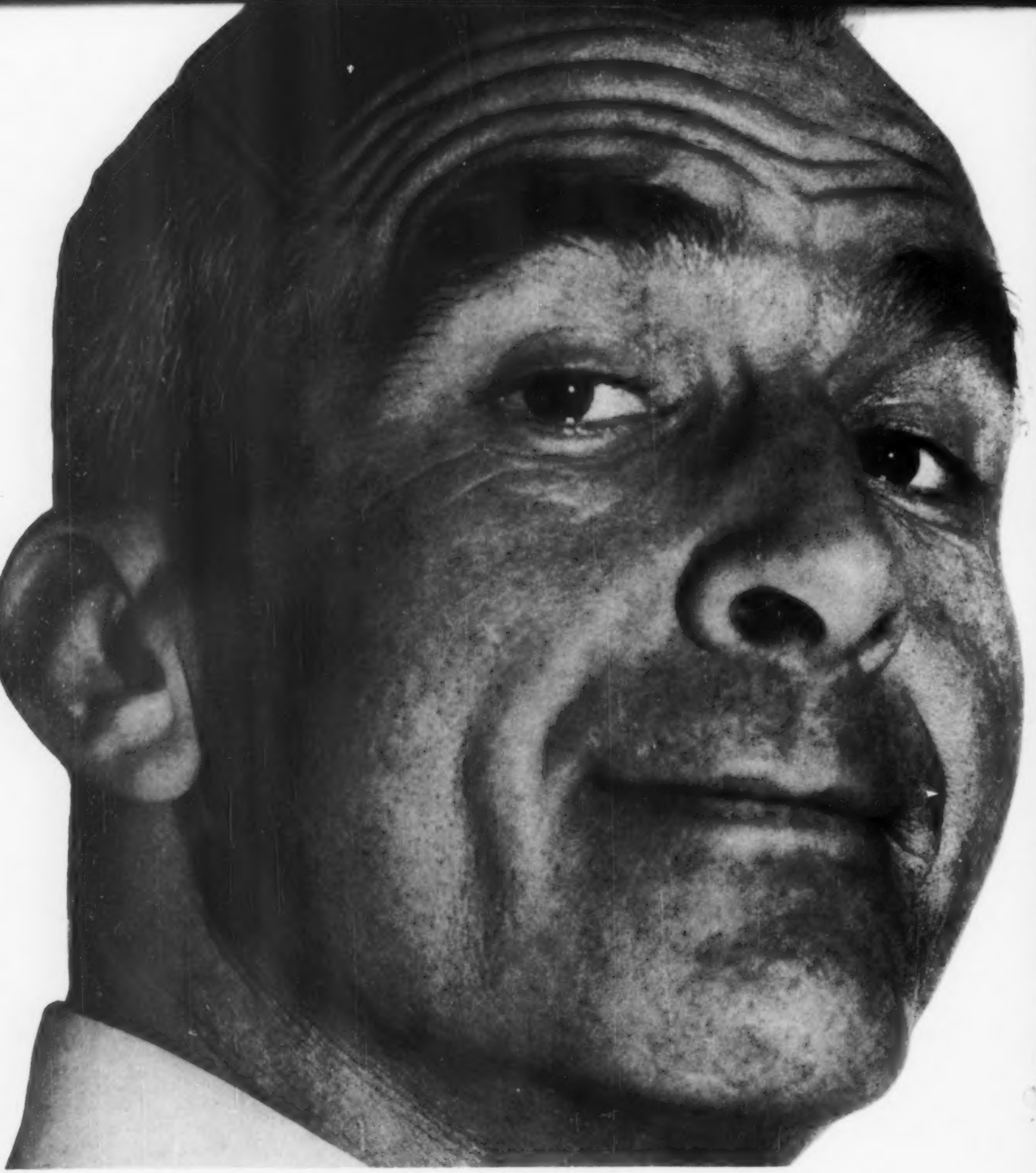
Because of possible confusion arising from similarities between company names and the name of this publication, the management states that neither Modern Plastics magazine nor any of its employees has any proprietary interest, financial or otherwise, in any company engaged in any phase of the plastics business itself.

In those instances wherein any company has chanced to use the name Modern Plastics or any similar words in its company name, it was not with our consent nor are we able to withhold such consent except as it applies to a publication.

One of the reasons for this clarification is that for 33 years we have taken great pains to build a national and international reputation for our name and for Modern Plastics as a publication. Our purpose as a company is solely devoted to the broad interests of the plastics field and to the informational and educational job that Modern Plastics magazine performs.

Hiram McCann

Modern Plastics Executive and Editorial Offices: 575 Madison Avenue, New York 22, N.Y. Tel.: PLaza 9-2710; TWX: NY 1-3063; Cable address: BRESKINPUB.



message for a molder from Missouri

This man has heard of the G-E Value Concept; we've talked about it in our phenolics advertising for a long time now. But this man is wary of slogans. He wants to be shown. Fair enough. "And what's in it for me?" he asks. Fair question.

The G-E Value Concept holds that phenolics offer molders and end-users properties that are unequaled by any other plastic material. No other plastic has the combination of heat resistance, dimensional stability and rigidity that phenolics provide.

All right, but why G-E phenolics? Where is the extra value there? In the first place, G-E compounds are top-quality and that quality is closely controlled. We make a broad line of phenolics. That means one source, one responsibility.

General Electric is research-minded. Through the development of new molding powders and better processing techniques, we create new profit opportunities for molders, a wider choice of properties for designers.

Finally, G-E technical service helps molders find the right compound for each job, then helps them get the job into profitable production.

That's the G-E Value Concept of phenolics. Molders from Missouri (or elsewhere) can see it in action by writing General Electric Company, Section MP-60, Chemical Materials Department, Pittsfield, Massachusetts.

Phenolics-first of the modern plastics ...first in value

GENERAL ELECTRIC